RECORD

OF

SCIENTIFIC PROGRESS

FOR THE YEAR 1891

EXHIBITING THE MOST IMPORTANT DISCOVERIES AND IMPROVEMENTS IN ALL THE BRANCHES OF ENGINEERING, ARCHITECTURE AND BUILDING, MINING AND METALLURGY, THE MECHANIC ARTS, INDUSTRIAL TECHNOLOGY AND THE USEFUL ARTS, PHOTOGRAPHY, CHEMISTRY, MEDICINE AND SURGERY, PRINTING, THE GENERATION, MEASUREMENT, TRANSMISSION, AND APPLICATION OF ELECTRICITY, THE TELEGRAPH AND TELEPHONE, METEOROLOGY AND AERONAUTY, ASTRONOMY, ETC.,

BY

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TO THE

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PREFACE.

In these days of progress, scientific knowledge is more extended in scope and diffusion, and influences each year more people; so that the number of those not interested in scientific advancement is rapidly decreasing. But scientific books and periodicals are already so numerous that it would be impossible for the average person to read even a small portion of those in his own language, to say nothing of those which, being in foreign tongues, are not directly available to the majority.

To serve the millions for whose pleasure and benefit science must no longer be a sealed book, who wish to be reasonably well-informed on practically the whole range of scientific progress, but who may lack time and opportunity to read more than a few of the excellent special periodicals from which the text-books and cyclopædias largely draw their data, I have prepared these pages, which I hope will save time and eyesight to the unscientific, and serve for ready reference to those whose thought and action lie within technical circles.

As far as practicable, the best periodicals and

other sources of information in the entire range of useful science have been laid under tribute, and leaders in inventive and manufacturing circles have added from their knowledge. From the immense mass of material thus gathered and received the main items of interest have been selected, divested of unnecessary detail and couched in simple language, suited to the mass of intelligent English-speakers.

I have tried to make the record complete, concise, popular, useful, interesting, convenient, and accurate.

I should be glad to receive for next year's record authentic data concerning new and important inventions, investigations, and discoveries.

ROBERT GRIMSHAW.

21 PARK ROW, NEW YORK.

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STEAM ENGINEERING.

Despite the wonderful advances made in the science of electricity, and in the many applications thereof, steam is still king of the forces by which civilized man is enabled to make progress against those of nature, and to increase his supremacy over his less progressive fellows; and a record of the triumphs in steam engineering is to some extent an index of the degree of such progress.

The science or profession of steam engineering has been set apart from the rest of mechanical engineering, once so called, because of the extent of its scope, and of the peculiarities which make it necessary to be studied as a separate science and practiced as a separate art.

The past year has been noted in this particular for progress made in marine engines, particularly in the development and application to the propulsion of large vessels in successful commercial practice, of the

triple and quadruple expansion engines, and the application to locomotives of the compound principle.*

STEAM ENGINES.

The *City of Paris* has been furnished with a device which controls the engines and stops them when they exceed a fixed number of revolutions. To the ordinary steam and hydraulic starting gear there is attached a small steam cylinder which has always steam in it, being supplied from the same pipe as the starting engine ; the idea being that whenever steam is on the starting cylinder the smaller cylinder should be ready for work. A weighted bell crank that can be adjusted to any number of revolutions is kept reciprocating by a small lever from the air-pump lever. Should the main engine turns exceed the desired number (in this case 120 per minute) the inertia of the weight causes the upper bell crank arm to engage a detent on the small steam cylinder's valve plunger ; on the ordinary starting gear there is a differential attachment on the hydraulic cylinder. The lever that admits steam for moving the links lets oil or water to either side of the piston. The controlling machine does not move the lever, but moves the fulcrum on which it works far enough to bring the valve in a position corresponding to the mid-position of the link.

Experiments have given satisfactory results with "assistant cylinders" for marine engines, in which by the direct pressure of steam or of water, exerted in the cylinder, the valves of large and fast-running en-

* See under the head of Locomotives.

gines may be driven without the use of complicated and cumbersome machinery.

NOVEL TANDEM ENGINE.

A tandem compound steam engine by Clarke, of British Columbia, is for driving twin screws. There is a crosshead between the high and low pressure cylinders; and this operates two connecting rods, one for each crank of the two shafts. On the crank are two crank arms pivotally connected by opposite pitmen, with a slide mounted in vertical guide ways, supported on a frame erected on the base, the motion of the crank shafts causing the vertical sliding motion of a piece traveling loosely in the guide ways, and thus serving as a governor, as, in case one of the propellers becomes disabled the power of the shaft carrying the disabled propeller would be directly transferred to the other shaft through the crank arm, pitman, and slide.

The tugboat *Edwin Hartley*, plying in New York harbor, has been equipped with an ammonia-steam condensing engine.

A new Corliss gear by W. Walker, of Manchester, drives the admission and exhaust valves by separate eccentrics. The hardened contact pieces of the releasing gear work in an oil bath, thus minimizing the wear.

Corliss engine dashpots are now run at a speed of 160 to 170 lifts per minute in this country.

The compounding principle has been applied to

steam road rollers by the Burrells, of Thetford, England.

A new oil pump for continuous lubrication of shafts screws on a bracket at such distance from the shaft as will permit a leather-covered eccentric, which it bears, to play on the shaft. The eccentric drives the arm of the pump; the oil is contained in the main stem of the device. It will work whichever way the shaft moves, so long as the shaft is not greasy where the eccentric rotates against it.

Klein proposes an apparatus by which the cooling effect of air may be brought into efficient play for condensing steam in an engine; and although water is used as an intermediary, there is very little new water required. The water which has been made to condense the steam, is made to flow through a tower in which an upward current of air is passed by a fan. The apparatus for a 100 H. P. engine covers six by nine feet on the ground; the fan ventilator is 6½ feet diameter, and the apparatus is for cooling 8800 British gallons of water per hour from 38° C. to 22° C. with a loss of three per cent. of the water. It is claimed that the water, which is used over and over again, becomes almost free from dissolved air, and when at 22° C. gives a better vacuum than ordinary spring water at 10° C. There is a water tank at the bottom, a fan above it at one side and a system of parallel boards from which the water trickles. Of course there is a pump, and that and the fan take power to run them.

A crank device, for the purpose of preventing sin-

gle cylinder engines stopping on the center, consists of a slot arranged diagonally in the crank disk, in which the crank-pin brasses can slide, being held at the outer end of the slot by a strong spring which overcomes the ordinary pressure of the connecting rod, but which permits the brasses to give way from the center, in case the shaft center and the crank-pin are in line with the crosshead. A spare brass is carried in the slot and forms a cupped plate to hold one end of the spring.

A radial steam-jet exhauster has been produced, taking advantage of the fact that small jets are more efficient than large ones. The steam issues radially between two disks fixed at the end of the steam pipe. Openings through these disks lead into branches connected with the suction pipe through which the air is drawn. The thin radial stream of steam flowing through these openings takes up its full complement of air. Considerable saving of steam has been found.

Kneas has made experiments showing that the velocity of steam through a well-proportioned orifice is nearly constant for all pressures.

Westinghouse has invented a compound direct-acting engine combined with a compound compressing pump having the initial compression cylinder and a smaller final compression cylinder, the pistons of which are directly connected to those of the engine cylinders.

In a new steam engine indicator by Perry, the pistons and cylinder are discarded. Instead of them

there is a thin steel drumhead. The steam pressure in a box of which it is the head bulges out the disk. The mirror is set about half-way between the center and the edge of this disk, and as the pressure bends the disk a beam of light, reflected from the mirror, is developed in one direction. The drum is moved in another angular direction by a lever which moves the spot of light at right angles to the pressure direction. The result is that the spot of light traces a true diagram of the working of the engine. The barrel cord is superseded by a rigid rod connection. The diagram made by the instrument may be made permanent by tracing it with chalk or pencil, even at sixty turns per minute. With such an indicator, the engineer may have before him not only the water, boiler pressure, vacuum, and other gauges, but the indicator diagram also. Perry has succeeded in getting diagrams at a rotation speed of 1500 turns per minute.

The Serpollet steam carriage has been tried with success in Paris and in London. As shown on page 315, *Engineering*, for March 13, 1891, and as made by J. & O. C. Pierson, of 103 Rue Lafayette, Paris, it is in the form of a mail phaeton. It has a boiler of the Serpollet type, consisting of three rings of flattened steel or iron tube. The products of combustion and the exhaust steam are carried out at the rear. The exhaust is superheated so as to be invisible.

Shand, Mason & Co. have made a steam fire engine for New South Wales which raised steam from cold water to 100 pounds pressure in 10 minutes 24 seconds, and with 250 feet of hose sent a stream of water 318 feet through a 1¾-inch nozzle.

Steam traction wagons are to be used to haul ore from the San Bernardino mines in California, 100 miles across the Mojave desert. Each engine hauls two trail wagons which have on them auxiliary engines, supplied with steam from the 20 H. P. boilers of the traction wagons. Each set of hauling wagons is expected to make a trip every two days, hauling 20 tons of ore.

The *Leipziger Tageblatt* says that four-fifths of the world's steam engines at present in operation have been constructed within the last quarter of a century. France possesses 47,590 stationary engines, 7000 locomotives, and 1850 marine engines ; Germany 59,000 stationary engines and boilers, 10,000 locomotives, and 1700 marine engines : Austria, only 12,000 stationary engines and 2800 locomotives. The force of the steam engines in operation in the United States is equal to 7,500,000 horse power, of those in England to 7,000,000, in Germany to 4,500,000, in France to 3,000,000, and in Austria to 1,500,000 horse power. In these figures the horse power of locomotives is not included ; in the beginning of 1890 the total number of the world's locomotives amounted to 105,000, representing from 5,500,000 to 7,000,000 horse power. Taking the figures as only 6,000,000, this gives the total horse power of the whole of the steam engines and locomotives on the earth of 40,000-000. The horse power of a steam engine may be estimated as equivalent to the power of three horses, and the power of a horse as equivalent to that of seven men. The world's steam engines, therefore, represent the enormous total of 1,000,000,000 men, or double

the number of workers in the world, the total population of the earth being estimated at 1,460,000,000 souls.

STEAM BOILERS.

A marine boiler invented by Buckland, of Newcastle, England, and known as the Stanley boiler, has at the bottom a cylindrical fire box, surmounted by the boiler proper, which has a spherical shell, cut away slightly at the bottom where it joins into the furnace. The fire box is surmounted by three combustion chambers, built as portions of a sphere, the center of which coincides with that of the boiler shell, and communicates by tubes passing through the outer shell with the smoke box, which completely surrounds the shell. The smoke box is divided into two parts, the lower communicating by large tubes with the inside of the fire box, to permit part of the gases of combustion to go into this lower part and then back by small tubes into the combustion chamber, thence through a third set of tubes to the upper part of the smoke box, and thence to the stack. The evaporation from and at 212° F. on a 1½-hour's run was 11.07 pounds of water per pound of coal.

The Babcock and Wilcox principle of sectional boiler construction has been adapted to marine boilers, the chief alteration being the adoption of smaller tubes and of vertical tubes at the side, instead of the brickwork of the land boiler. In place of each of the four-inch inclined tubes forming the bulk of the heating surface of the land boiler, there are four 1¼-inch tubes.

Yarrow & Co. of Poplar, England, are getting good results with a tubular boiler having a horizontal upper chamber or reservoir and two lower chambers, each of the latter occupying the space at the sides of the fire chamber. The reservoir is connected to the lower chambers by numerous straight lengths of pipe, composed of weldless steel tube. The parts of the chambers into which these are inserted are flattened so that several rows of tubes can be used.

Seller's water tube boiler consists of two drums, each of which is practically a quarter cylinder, connected between their flat sides by tubes bent to a quarter circle and having one long and one short arm. These sectors lie across the fire chamber, one at its bottom, at the back, resting on the back of the bridge wall, and the other in front and considerably higher, the connecting tubes running lengthwise of the fire chamber. There is a third cross drum, which is cylindrical and lies at the back and upper part of the combustion chamber and is connected with the upper sector by horizontal and with the lower one by vertical tubes. A lengthwise drum is connected with the upper sector and with the cylindrical drum by large necks; and suitable partitions of fire brick cause proper circulation of the gases of combustion.

A new form of furnace for boilers is known as the "Spanish" type, the plate being of uniform thickness and the form something like that of the Purves' furnace, there being a series of separating ridges projecting into the water space at nine-inch intervals. Between these ridges the material is disposed in the

form of a catenary curve, the object being to secure uniform resistance to collapse throughout the length of the furnace. This long curve also presents no cavity for the undue accumulation of scale. A furnace of this kind 37 inches outside diameter, 7-16 inch thick, was tested under cold water pressure and resisted 1140 pounds per square inch before deformation took place.

A lengthwise-ribbed boiler tube has been tried in this country during the past year. The ribbed tubes have about double the heat-receiving surface exposed to the flame by the ordinary tube, and the same outside or discharging surface. The Paris, Lyons, and Mediterranean Railway is fitting forty engines with these tubes.

In a new automatic water gauge for marine boilers the closing gear consists of a small cylinder mounted on a trunnion on the gauge standard, and connected above the piston to a point between the top gauge cock and the glass, and below the piston to the boiler. The difference in the total pressure on the sides tends to keep the piston at the bottom of the cylinder, in which position the cocks are open. The piston rod is connected by a link to the gauge cock handles, which are arranged with a quadrant, permitting their being worked independently of each other and of the closing gear. On the bursting of the glass the pressure on top of the piston is removed, and the closing of both the steam and the water cocks is practically instantaneous.

Goodbody has designed an apparatus for prevent-

ing and separating the incrustations of steam boilers while aiding in the lubrication of the engines. There is injected into the feed water a hydrocarbon, which may be the residuum of petroleum distillation, a neutral product, or a sub-product of the distillations of schists containing hydrocarbon oils. There is an injector, the operation of which is based on the difference in density between the hydrocarbon and the water. Where there is no feed water heater, the disincrusting apparatus is in front of the check valve and slightly above it ; but if there is a heater, the anti-incrustator is placed in front of the latter, so as to prevent the formation of scale in the heater as well as in the boiler.

Kellner proposes to line steam boilers with an anti-acid coating of slate ground with water glass, then with blocks or slabs of ground slate and Portland cement mixed with water glass. As to the non-conducting properties of such a coating he says nothing.

Cork as a boiler and pipe covering has been tried on ocean steamships, with the result of lowering some temperatures 100° and even 124° F.

The immense steam pipes for the great Ferranti dynamos are composed of smaller pipes bunched together.

A furnace-mouth protector, consisting of a tubular casing with water circulation, is intended not only to protect the furnace mouth, but to act as a feed water heater.

In a new smoke-annihilator the air, after passing under the fire grate, goes through an opening at the bottom of the fire-bridge and, coming in contact with the carbon monoxide and hydrocarbons which have escaped combustion, consumes these gases, rendering them useful by utilizing the heat produced in their combustion. There is a drop arch at the point where the heated air enters, and this, becoming incandescent, maintains the temperature required for the combustion of the carbonic oxide to carbonic acid.

Lavington F. Fletcher read a report to the members of the Manchester Steam Users' Association, going to show that the idea that nearly every explosion is attributable to shortness of water has had a very mischievous tendency. The results of his tests, which were very elaborate, go to show that showering cold water on furnace crowns when red hot did not lead to their rending by sudden contraction either transversely or longitudinally, nor did it cause a violent generation of steam which the safety valves could not control and the shell could not resist. On the injection of the feed when one of the safety valves was seated and the other open, the pressure rose in 1¼ minutes from 6 pounds to 12 pounds, and when both safety valves were seated it rose in ¾ of a minute from 6 pounds to 27 pounds, and then gradually fell off. On the injection of feed when the safety valves were blowing, no increase of pressure could be observed. On the contrary it began to fall, and the handle of the pressure gauge to glide back. There was no collapse, there was no rent, either in the furnace tubes or in the shell, and no

movement of the boiler whatever. . . . . The experiments, as far as they have been carried, lead to the conclusion that in the majority of cases turning on the feed, when delivered behind the fire bridge, would be the best thing to do. It would cool down the boiler, restore the water level, re-invigorate the plates of the furnace crown, and be a safeguard to the attendant while he was drawing the fires.

GENERAL MECHANICAL ENGINEERING.

THE science, or art, or profession of mechanical engineering is now made subservient to so many others, and the triumphs and everyday successes of these latter are so dependent upon the achievements of the mechanical engineer, that it seems hardly fair to the latter to chronicle under the heads of "Steam Engineering," "Marine Engineering," "Locomotives," "Machine Shop Practice," "Wood Working and Textile Machinery," etc., progress which is so largely due to the inventive and constructive ability of the mechanical engineer. Yet the very fact of this department being so extended is the reason for referring the reader to the particular heads mentioned for a chronicle of so much that is interesting and useful that has been done during 1891.

There are, however, some lines which by reason of their more limited application, and the comparatively small number of those engaged in them, may still be chronicled under the general head of Mechanical Engineering; and these will be found below.

NEW GAS AND PETROLEUM ENGINES.

In the direction of gas and oil motors, the Otto builders count among their latest achievements the adapting of their engines for the use of liquid gasoline, and are now fitting them for coal oil in a manner which dispenses with pumps, intermediate chambers, etc., and their complications. This engine has been put upon the market by the German factory at Deutz, and should very shortly be in the hands of Americans. The same builders are now exploiting the use of producer gas with gas engines. The gas is made upon a continuous process by air and steam passed through incandescent coal. From the generator it goes to a scrubber for cleaning and cooling, and thence to a small holder, from which the gas engine draws its supply; and in case the production of gas exceeds the consumption, the holder, when full, strikes a stop, cutting off steam and air from the generator, and thus suspending the making of gas until the holder drops.

Tests (made by Prof. K. Teichmann, of the Royal Technical School of Stuttgart, and M. F. Bocking, Chief Engineer of the Rhenish Society for examining steam boilers) show that a twin cylinder Otto engine working with producer gas developed a brake power of 52 horse power, with a total fuel consumption, including that used for the super-heating boiler, of 1.6 pounds per brake horse power, or barely 1.3 pounds per indicated horse power; the latter, however, being a figure not strictly comparable with the figures of indicated horse power from steam engines; the brake horse power figures being those which should

be compared with brake horse power figures from steam engines.

An automatic starting gear for gas engines has been brought out by Crossley Brothers of Manchester, England.

Mr. Edward Butler, of Greenwich, Eng., is said to have produced a petroleum motor tricycle which will run 40 miles with one gallon of oil.

AN ETHER ENGINE.

Susmis' ether engine has a horizontal motor with four single acting cylinders united in pairs and inclosed in a cast iron chest filled with glycerine. The generator, placed under the engine, consists of two horizontal heating tubes connected by a bundle of curved tubes holding the ether and surrounded by a cylindrical iron plate jacket filled with water, forming a thermo-syphon that effects the distillation of the ether. Above this jacket there is a receptacle containing glycerine, which has a series of pendant tubes entering the water of the thermo-syphon. The glycerine becoming heated in the tubes, rises to the surface, circulates all around the motor, and returns to the lower part, making the same journey over and over again. The vapor of ether reaches the motor through a tube surrounded by a second tube containing water at the lower part and glycerine at the upper, and which prevents condensation of the vapor before it has acted upon the pistons. A metallic cut off, traversed by the ether added, prevents the mixing of the water and glycerine in the heating tube. The glycerine is kept at a temperature above

the condensing point of the ether; and as the two liquids have no affinity there can be no mixing even in case of a leak. Further, the glycerine is a good lubricant for the machine. On leaving the cylinders the ether vapor goes to a aëro-condenser in which there is an air current that has been cooled by the atomization of water.

Another machine of the same inventor receives steam from a boiler, and after operating in the cylinders this steam flows through a curved pipe into a condenso-generator formed of a series of vertical tubes inclosed in the cylinder containing the ether. The steam condenses in these tubes, and the heat that it gives out develops vapor of three atmospheres pressure in the ether; this operating a small motor like the one described, and then returning and being condensed in the aëro-condenser.

THE PNEUMATIC HOIST.

The range of hoisting apparatus has been supplemented by the introduction of the pneumatic hoist, which is intended to reduce the time and labor required to lift a load, and incidentally to increase the amount of work that a machine, tool, or other appliance can turn out by its use. It has these features of the ideal hoist, that it requires no manual labor to operate it, and that it lifts a load readily. It consists of a length of hydraulic iron tube, reamed out inside to greater smoothness than could be obtained by boring, and doing away with the necessity of bushing with brass; to the upper end of this is attached an ordinary iron cap with a hook by which it may be slung to a trolly crane or other arrangement for giv-

ing horizontal movement. The lower head is made of two castings, one of which is screwed to the end of the cylinder and has a lug to receive the screw end of the valve which is for supplying the compressed air for lifting. To the lower ring is attached a head which is held in place by four small studs and nuts, and which contains the stuffing box, for examining the piston and its packing without disturbing the hoist. The piston is a cast iron head with a follower plate and a leather cup-ring. The lower end of the piston rod has a swivel to let the ring be turned to any desired position. The piston is raised by air pressure and lowered by the weight of the load, or by its own weight. The valve consists of a body, a stem, a cap, and a small spring to keep the same in place. The capacity of a three-inch diameter hoist with 80 pounds pressure is 450 pounds ; of an eight-inch with the same pressure, 3200 pounds. From this, the duty may be readily figured out.

HUGE STEAM CRANE.

Ransomes & Napier, of Ripley, Eng., have made a huge steam crane, called a Titan, for the Madras Harbor Works, where it will be used in carrying 32-ton concrete blocks. Its weight, without water ballast or load, is 152 tons ; with ballast 170. It cannot only slew around its own center, but travel on a curved road on the break-water ; being carried upon twelve wheels arranged as two four-wheel bogies, having four driving wheels between them. It will travel about a 90-ft. curve. Its arm travels in a curve of 50 ft. radius, and the slewing is stopped gradually by springs.

A balanced steam hydraulic crane acts by a head of water alone, or by a combination of steam and water, the steam pressure acting on the inclosed mass or piston of water. In the latter case the water is used over and over again.

Ravelli has produced a helicoidal windlass in which he employs screws of very close pitch, at the risk of increasing the loss of work due to friction, but with the intention of decreasing the liability of their running down backward. There is a very large disk, having a screw thread upon its edge or cylindrical face and gearing with pins on gear wheels borne by the ends of the hoisting drum. Stoppage may be secured under full load in raising or in lowering, without a brake, and the handle cannot fly back.

A gigantic elevator for the North Hudson Co. Railway, Weehawken, N. J., is in a tower with a base 45 by 60 feet, reaching to 197 feet above the water level, the cars having a lift of 148 feet. There are three cars, each 21½ by 12½ feet. The hydraulic elevated cylinders are 38 inches diameter and two inches thick with 50-inch flanges. The car moves six feet for every one of the piston travel. Each car has a capacity of 20,000 pounds raised 200 feet per minute ; each will carry 135 passengers. These elevators are worked by the combined gravity and pressure system, by water from an overhead tank in which there is compressed air.

Briquettes are to be made from Victorian brown coal if the process can be made to pay.

A new diamond-tooth stone-cutting saw has been produced by Kohler. In it the method of holding the teeth is to take a small bar of soft steel, bent into a very narrow V, and putting a diamond between its branches, to solder them while hot, and expand them so as to constitute a disk, in which the diamond is held without any soldering material. There are in the saw disk as many cavities as there are teeth.

A sectional bushing has been devised by which to draw stuffing box packings, when they get hard, without removing or injuring the rod.

Thos. R. Almond, of Brooklyn, has devised a new flexible metal tube, which he showed at the meeting of the American Society of Mechanical Engineers, and which consists practically of a round wire spiral, having a spiral worming of triangular wire.

Weldless steel chains are produced from a solid cross-shaped bar through which at proper intervals holes are drilled ; then the block is notched roughly to the shape of the links, flattened to prepare it for hollowing out the links, and stamped to round them up. Next the blank is punched through and the links parted. Such chains are free from defective welds, and being of steel are stronger than those of iron.

A method of making rolled steel tubes of desired size inside and out, and finished both inside and out suitable for plating, is to take a hard smooth mandrel of the least diameter that it is intended to have the

tubes, but longer than the greatest length desired; to cover it with oil and black lead, insert it in the tube, then roll the tube through hard surface rolls until the desired outside diameter is reached, after which the mandrel is removed. Compound tubes, that is those of one kind of metal covered or lined, or both, with another kind of metal, have also been produced. Those lined with another metal are made by taking a hard mandrel of the diameter required for the inside of the lining, placing the lining on the mandrel and rolling it down to the diameter of the latter, then slipping the tube that is to be lined over the lining, and rolling it down to cover that, after which the mandrel is slipped out. If the tube is to be covered as well as lined the mandrel is left inside, the metal cover is slipped over the tube, and rolled down until it is closed thereon. It is believed that excellent boiler tubes may be thus produced, by covering steel tubes with copper, which latter is placed next to the water to avoid corrosion. In making a joint in the tube plate, the copper acts as a ferule between the tube and the head.

Handling coal by steam is now done by placing between the hatches of an ordinary collier a small high speed engine driving shafts which are temporarily bolted at one side of each hatch. Each shaft carries three grooved friction spools. Workmen by bearing down on a treadle cause the friction wheels to engage the spool, which in turn lifts the bucket from the hole. Steam is supplied by hose from portable boilers on the deck. About thirty minutes are required to place the plant on deck and ready for

service. A collier which formerly required 72 men 24 hours to unload, in now unloaded by this method in 12 hours with only 30 men.

A new style of conveyor for coal and like materials, instead of employing the usual sprocket wheels for effecting motion, has pawls for pushing the chain along, a second pawl taking hold before its lever lets go. The buckets are borne on wheels, an axle extending across from track to track between each pair of buckets while the buckets themselves are pivoted upon the wheel-supporter bearing at each side.

A new piano-tuning pin consists of a bell-crank lever pivoted at its angle, and having a string fastened to one of its arms. The other arm has passing through it an ordinary machine screw which bears upon the main frame and which by the aid of an ordinary screw-driver may be made to put greater or less tension on the wire.

A new lock-stitch sewing machine has the under thread supplied from the spools on which it is bought, not only saving time but preventing waste of thread.

A new way of lubricating loose pulleys is by tubes extending from the rim to the hub. These tubes being threaded internally, a grease candle being inserted in one is kept close to the hub by a follower, which may be screwed down the tube. When the candle is exhausted, the follower may be screwed out and a new candle put in.

Forked rivets are now used for making and repair-

ing belting, harness, etc.; they are driven into the leather, pushing it aside, and then can be clinched, without any reduction of the section of the leather. The points are turned over very fully and bent back into the material so that there are no sharp edges left.

A wire loop holder by Strohbach is for making a secure loop in a wire rope in a few minutes, by an unskilled workman. The holder consists of a cast iron block with four holes; the rope is passed through the end of the block and out by one of the side holes, then curved around to form the loop and passed through another side hole and out at the end; there being a tapered space between the two parts of the rope in the block. A cast iron wedge, hollowed at its sides to fit the rope, is passed into this space and driven home by a screw plug which passes through the fourth hole in the block. When this wedge is driven home it grips the rope firmly against the sides of the block. To take the wear and preserve the rope a lining of galvanized iron is placed inside the loop.

HYDRAULIC ENGINEERING.

In the department of hydraulic engineering by far the most important work is that now going on, looking to the utilization, at a very early date, of at least a portion of the immense power now going to waste at Niagara. The Cataract Construction Company has been a long time getting ready for this work, and has availed itself of the services of the most eminent consulting engineers of this country and Europe. In

order to be sure that every desirable plan shall be properly presented by constructing engineers for the consideration of its consulting experts, it offered prizes for the best plans for the successful utilization of the power and its mechanical transmission from the place of generation to neighboring, even somewhat distant, manufacturing sites.

Of the many plans offered in competition, only seven were electrical, going to show that electrical engineers are not yet ready for a problem of this magnitude. Of these, two suggest alternating currents of from 5000 to 10,000 volts, and others propose direct currents of from 1600 to 4500 volts.

In Cuenod, Sautter & Co.'s project for taking the whole 125,000 horse power, they propose two arrangements, the second of which provides for the machinery upon the surface, using turbines with suction pipes and vertical cases ; fifty for regular working, six for reserve, each producing 2500 horse power at 136 turns per minute. The dynamos are above ground ; each upon the shaft of a turbine which is to be supplied by a 67-inch wrought iron pipe and to have a 12-ton fly-wheel. The shaft is supported by a cylinder and piston in the turbine case, water under 105½ feet head acting beneath the piston. Each turbine has a relay governor, while the sluices or tunnels are worked by hydraulic pressure under the control of the governor. Each gallery is to have 28 dynamos, forming four circuits, two at 2500 volts, two at 500, and a neutral wire. The resultant efficiency is 39 per cent. for Buffalo and 84 for Cataract City. The total cost per horse power is estimated at $12.70 for Buffalo, and $9.88 for Cataract City.

Vigreux and Levy propose three alternative plans for hydraulic machinery:

(1) Groups of four axial-flow pressure turbines of 2500 horse, which are coupled in pairs and drive a dynamo each side at 300 turns; a short supply pipe, 8½ feet diameter, leading from a vertical rock channel, feeding the group of turbines.

(2) Groups of two inward-flow pressure turbines of 5000 horse each, with horizontal axes, so arranged that each one drives a dynamo each side.

(3) Groups of four outward-flow pressure turbines placed opposite in pairs or not axially coupled.

In all three systems an ordinary pendulum governor acts on the distributing valve of a hydraulic cylinder worked by the pressure of the head which drives the turbines. For 120,000 horse power there are 12 groups of turbines, one of which is for exciting and the others for local lighting, and there are two reserve groups. All 14 of the groups are to have separate vertical water shafts. The electric current is to be continuous and of 5000 volts; the dynamos of 2500 H. P., 330 ampères, 5000 volts. Each machine has two armatures of the Gramme ring type, because it is difficult to get more than 3000 volts with but one ring. The out-going conductors to Buffalo are five bare bars 4.6 square inches in section; the return conductors the same. To transform the current at the far end motors are employed, driving low tension dynamos. The efficiency to Buffalo is to be 85 per cent., that of the whole electric line to Buffalo 68.85 for high tension and 62 for low; total cost per electric horse power distributed $23.60 per year.

Hillairet & Bouvier propose 13 turbines of 10,000

horse each, each working a single dynamo, above ground, by a vertical shaft; turbines to be of the impulse type with partial admission and to make 80 turns per minute. For each turbine there are to be two vertical shafts through the rock, one for supply and the other for access and to carry the driving shaft. The dynamos are to give a maximum difference of potential of 1000 volts with 7000 ampères of current. Consumers using motors of not less than 25 horse power are to receive current at 1000 volts; those not less than 50 H. P., and between two and three miles of the center of the city, 2000 volts; smaller motors to receive 100 to 200 volts current.

Popp & Riedler propose transmission by compressed air; figuring on an initial pressure of eight atmospheres and final of six, the leakage being about two per cent. A frictional resistance of 1.2 pounds per square inch per mile of main is assumed, with a mean velocity of the air of 34 feet per second. Thus 25,000 horse power could be carried to Buffalo by air of 114 pounds at Niagara, becoming 88 at Buffalo; there being two mains each 2½ feet in diameter, and the loss in friction 11 per cent. Seventy-five thousand horse power at an initial pressure of 199 in the same mains would give 18½ per cent loss; 125,000 H. P. at 285 pounds initial and a mean velocity of 55 feet per second being transmissible by the same mains. For 25,000 horse power the cost per horse power at Buffalo is estimated at $12.05 per year; plus five per cent. interest on the plant, $31.12. The commission preferred vertical turbine axes and intermediate compressors.

Deacon & Siemens Bros. propose groups of 12 tur-

bines each, each of 2500 horse power, or 30,000 horse power in all; each group to be supplied by a 20-foot vertical channel communicating through a horizontal channel with 12 iron supply-pipes; turbines to be of the inward-flow pressure type with horizontal axes and suction pipe. No regulating apparatus is proposed. The wheels are to be six in number and to run at 195 turns, being in two rock galleries 780 feet long, connected by cross galleries. To each turbine is to be rigidly attached a dynamo giving a constant current of 400 ampères with a potential depending upon the speed; at 195 turns being 4500 volts. One generator is to start with voltage enough to send 400 ampères through the mains; its speed increasing as the resistance increases, until it reaches full speed; then another generator to be started and run a closed circuit until its current is 400 ampères, and then to be switched into the trunk main. The cost per horse power per year at Cataract City is estimated at $12.75; at Buffalo $23.05. The committee preferred parallel conductors and approximately constant potential.

Pearsall proposed to put, in an enormous open excavation, nearly down to the level of the tail water, 63 compressing engines in three tiers, each engine consisting of a vertical cylinder having valves controlled by special air motors. Three 34-inch mains are to carry air to Cataract City, two 30-inch mains to carry water.

Lupton and Sturgeon propose the use of low pressure air, one main carrying 125,000 horse power. They propose 8-foot turbines of 3750 horse power each, of the inward-flow pressure type, with draft tube; running 140 turns per minute on a hollow vertical

shaft. The air compressors are to be just below the surface, to be single acting, vertical, and 43 by 48 inches; eight being driven by each turbine at 80 turns, through a horizontal shaft geared by steel bevel wheels. At full speed each cylinder delivers 500 feet of cold air at 67½ pounds per square inch. The air is to be delivered by branch pipes into a main 10 feet in diameter, reduced to 7 feet at Buffalo, where the pressure will be 60 pounds. The cost, independent of interest, is estimated at $7.00 per horse power per year.

Ganz & Co., Buda-Pesth, propose to place each turbine and armature of the dynamo driven by it on the same vertical solid steel shaft; the combined weight being 125 gross tons. The turbines are to be 5000 H. P. each, of the partial flow impulse type, but at full flow to work as pressure turbines. The shaft is to be carried by a collar bearing and also supported by a hydraulic piston in the tail race. Alternating dynamos are proposed to work at 336 ampères at 10,000 volts. There are to be 12 large alternating dynamos. The cable is to have a total section of 1848 square millimeters, the loss to be 25 per cent. Reaching Buffalo at 8000 volts the current is to be transferred to 12,800 ampères at 2000 volts.

Escher, Wyss & Co., propose three plans. (1) A plant of 100 groups of air compressors above ground, driven in pairs by turbines of 2500 horse power, with vertical axes and gearing. (2) Twenty-five turbines each of 5000 horse power with vertical shafts to dynamos directly above. (3) A plant of 12 turbines each of 10,000 horse, with horizontal shafts, each driving two intermediate dynamos. The turbines

to be directly over the tail race tunnel, in galleries across the tunnel, leaving the rock solid between the series of supply shunts.

Rieter & Co. propose wire rope transmission by cables each carrying 333 horse; pulleys to be 330 feet apart. The loss is said to be seven per cent. for each span. There are three hydraulic projects to drive the rope. (1) Four pressure turbines with draft pipes, running 180 turns, each giving 2000 H. P., and standing on a vertical shaft at the top of which there is a collar bearing on a beveled gear driving wire rope pulleys. (2) Four pressure turbines each of 3500 horse, with horizontal axes and draft pipes; wheels placed opposite in pairs, with collar bearings. (3) Two pressure turbines in each group, each of 5000 horse, running 190 turns on horizontal axes. By the first project the cost of the turbines is $14.16 per horse power; by the second, $4.57; by the third, $4.42. Including buildings and excavations, the costs are by the first, $28.16; second, $9.06; third, $8.09. The machinery for the central station for cable transmission is given at $3.25 per horse power; of transmitting cables and mid-stations, $5.25 per horse power for each 330 feet; receiving station $4.11 per horse.

Vigreux & Feray propose to deal hydraulically with less than half the power of the station; pumps being undermined in a rock gallery in three bays; the wheels to be 34 feet in diameter, of impulse partial admission type, on horizontal axes, two being coupled on the same shaft; each wheel to be 2500 horse; each pair driving six double-acting pressure pumps with an accumulator for each set of three pumps.

The speed of pumps and turbines is to be 30 turns per minute. The pumps are to have plungers 17¼ inches diameter, 30 inches stroke; and the water pressure to be 783 pounds per square inch.

The Pelton Water Wheel Co. proposes to use wheels 14½ feet diameter, in pairs, running 60 turns per minute; each wheel supplied by five nozzles with hydraulically worked valves. For air compressing, a 21½-foot wheel would be used, running 40 turns and having eight nozzles. The cost of water wheels, exclusive of excavation and erection, and exclusive also of pumps, compressors, and dynamos, is given at $3.90 per H. P. The wheels are to be guaranteed at 80 per cent. efficiency, and the makers expect 85.

A company has been organized for utilizing the water power of Lake Superior, and constructing very extensive works near Sault Ste. Marie. The water supply here is about 122,000 cubic feet per second, and the power about the 236,000 horse power. It is proposed to build a tail race five miles long on the Canadian side, and a canal as long on the American; each canal to be 1000 feet wide, which will be the greatest width in the world for such constructions. There will be dry docks on both sides, to be filled and emptied by gravitation.

INCREASING THE SUMMER SUPPLY OF THE NILE.

While we have been engaged on this continent with the problem of how to utilize what has been for so many centuries a most undesirable waste of water, the trouble has been in the oldest country in the world,

that their wonderful stream, historic and majestic as it is, the scene of the rise and fall of so many empires, gives to the country about it too little water for its real needs during the dry season which follows its fertilizing flood.

It has been officially decided that its summer supply is too slight and that there must be some steps to increase it. An International Convention met in December at Cairo to settle details.

Mons. Prompt proposes four or five dams between Assouan and Khartoum, 16 meters high, and self-regulating. The river in flood will pour over the crests of the dams, which will hold up 3500 million cubic meters,* the gradual discharge of which, when the Nile has fallen below 50 million cubic meters daily, would keep the low Nile at normal height.

Willcocks proposes a dam 1200 meters long and 25 meters high, at the base of the cataract of Assouan. The sluices in this dam would permit the passage of the entire flood.

De Bellefonds proposes a barrage about forty miles north of Assouan in a gorge raising the water high enough to permit the perennial irrigation of all Egypt.

Jacquet's idea is to close this defile with a masonry wall 400 meters long and 20 high; to make a new bed for the river on the right bank, to be closed by a movable dam with a lateral reservoir, 700 meters wide, cut out of the solid rock, to carry off the flood; a lateral canal with locks for navigation, and an irrigation canal having its inlet above the dam in the

* One cubic meter equals 1.308 cubic yards, or 35.32 cubic feet.

left bank. The depression two kilometers east of the present channel up the river would be closed by a solid dam 1300 meters long. This would give a reservoir having a surface of 1400 million square meters and storing 7000 million cubic meters, and which would deliver 35 million cubic meters per day besides the normal low water discharge.

DAMMING NIAGARA.

The water in the great lakes along the frontier has been so low that a dam at Niagara Falls has been suggested for increasing the depth, but a Government engineer in Chicago says that if dams are to be used they must be placed at the outlet of each lake ; that a dam at Niagara Falls might raise the water in Lake Erie two feet, but the effect on the upper lakes would not exceed two inches. To raise Lakes Huron and Michigan a dam across St. Clair River would be required. The only feasible way to get more water in the lake channels is to dig deeper.

For several years the level of the water in the lakes has been steadily falling, and it is now fully two feet lower than it was eight or nine years ago. This steady fall in water has constantly tended to lessen the cargoes of the great lake boats, and they are now five to ten per cent. less than they were half a dozen years ago. Captain J. S. Dunham believes that the lakes could be treated as great mill ponds, and the lessening of the capacity of the outlet would result in backing up water which would otherwise go over the Falls. His plan is a very simple one. In the Niagara River below Tonawanda, where navigation ends, he would dump many thousand boat loads of large

stones. It might be that some steel structure could also be extended to the river from each side to narrow the channel. The result would be to lessen the flow of water from the lakes and thereby increase the stage of water at all points.

HYDRAULIC ENGINEERING IN INDIA.

The hand of progress seems to be no respecter of centuries. Not only Egypt and the Nile are looked upon by the hydraulic engineer as but fair fields for his skill, daring, and experience, but India, the home of Buddha, the land of the Mahatma, studded with temples of religion that date back for ages, is considered as requiring to be brought up into a proper condition of sanitation and comfort, whether its native inhabitants desire it or not.

There is proposed in the southern extremity of the peninsula of India an engineering work of great magnitude and importance; being the turning eastward of the Periar, one of the streams of the mountains of Travancore, into the Vergel, from which it is separated by a mountainous wall. The idea has been broached many times during the last century; but it is now taken up by the Madras Government. There is to be a dam 150 feet high, 60 feet wide at the base, and tapering to 15 feet. This will raise the waters so as to make them flow back over the course of the river some 10 miles. At a point 7 miles back they will be led through a tunnel 5700 feet long and 7 by 10 feet in section. There have been spent already 2,000-000 rupees; there will be required about 10,000,000 rupees, or $4,000,000. Of the 38 miles of channel, 22 miles are already dug.

The great Tansa Reservoir dam for the water supply of Bombay was expected to be completed in April, nearly fifteen months in advance of the contract time. It is two miles long, 115 feet high, and 106 feet wide at the base. It contains 11,000,000 cubic feet of masonry. It was carried out by T. Craigie Glover, with 10,000 native masons. It is 60 miles from Bombay, with which it will be connected by iron pipes.

THE GREAT CROTON DAM.

New York is to have a great dam, to rise 159 feet above the Croton River, the foundations going down 70 feet. Its length between flow lines will be 1736 feet, and its cost is estimated at $3,650,000. The site for this, the Cornell dam, is about 1¼ miles above that which had been adopted for the Quaker Bridge dam, and 2¾ miles below the present Croton dam, and will give an additional drainage area of 21 square miles, and storage capacity of 30,000 million gallons. It will take five years to build.

RIVER AND HARBOR IMPROVEMENTS.

The work of improving Tampico harbor is progressing rapidly. In October, jetties had run 700 feet in length, and the depth was 24 feet. The distance between the two jetties is 1000 feet. The river when in flood has a volume of 225,000 cubic feet per second, and will deepen the bar 25 feet. The average current is five miles per hour. Since June 1, 1890, there have been gained 1400 feet of beach either side of the jetties. The mattrasses of brush are 70 to 85 feet wide at the bottom, and 30 at the top. It is claimed that when this work is com-

pleted Tampico will be the one safe deep-water harbor on the Atlantic coast.

The work of blowing up the "iron gates of the Danube" is now going on, and is expected to be done by 1895, when Black Sea steamers will be seen at the wharves of Pesth and Vienna, having touched at Belgrade.

Mr. E. G. Holden, of Fulton, Tex., has invented a device for scouring water-ways to increase their depth. Powerful pumps project streams of water and air under great pressure from pendant vertical pipes arranged in rings at right angles to the keel of the boat. The discharges of the water pipes alternate with those of the air pipes.

The difficulties of navigating the Missouri River are confined to two places—the mouths of the Osage and Grand rivers, which are about 150 miles apart—and the Government is trying to overcome them. At the mouth of the Osage an effort is to be made to confine the channel for about nine miles. The Missouri is very wide there, the waters spreading over low lands, and there has been no distinct channel. The depth of the water has been increased from 4½ to 7 feet. Piles 38 feet in length are forced into the sand and clay in five minutes by a powerful stream of water forced through a pipe extending to the point of each pile. The stream clears away the sand and clay, and the pile sinks of its own weight. It is believed that after the work has been finished the river will be navigable during nearly all the year except winter.

AN IMMENSE LUMBER FLUME.

A large flume has been built in California for carrying lumber from the place of felling in the Sierra Nevada to the plains below. It is 52 miles long, of timber; in section V-shaped, with a right angled vertex. The V is 21 inches deep for the most part, 43 inches across the top. At the lower terminus it is 64 inches wide by 31 deep. The sides are of 1¼-inch boards and the structure is carried on trestle work nearly all the way; in some places 130 feet high. The steepest grade is 1200 feet to the mile for 1000 yards, the fall being 730 yards in this distance. About nine million feet of lumber is used in its construction.

SHATTERING SUBAQUEOUS ROCKS.

The Lobritz system of demolition of rocks under water without explosives consists in shattering the rocks by the action of a heavy mass let fall from a convenient height and cutting like an artillery projectile. Experiments near Edinburgh show that a weight of two tons shod with a steel point and falling 5.5 meters (16.04 feet) broke more than 0.113 cubic meter (0.148 cubic yards) of hard rock per blow. A machine working at Port Said, having four steel-pointed battering rams, each of four tons weight, raised from 1½ to 6 meters, and giving in all 200 to 300 blows per hour, worked ten times as fast as the ordinary system in conglomerate rich in gypsum. The expenses, including repairs, were 8850 francs ($1770) for 1600 cubic meters (2092 cubic yards), making the cost 5.52 francs per cubic meter or

$0.84 per cubic yard, not including insurance, interest, and depreciation. Later results give only $0.65 per cubic yard.

IMPROVED WELL LINING.

An East Indian, Ganga Ram, has produced a new way of making wells, consisting in radiating and interlocking bricks of a special shape and design, and which when laid only one brick thick, dry or in mud and lime, serve the purpose of an ordinary well lining. Each brick has both a dovetail mortise and a tenon to grip those on either side and above and below, the mortises and tenons breaking joints throughout. No cement or tie rods are necessary ; the lining may be thinner than by the ordinary method ; the inflow of sand is reduced to a minimum without keeping out water ; and skilled masons are not required for building. Just how the bricks are to be made in perfect shape is not yet laid down.

IRRIGATION.

Those who make the desert to blossom as the rose, may well be considered as among our greatest benefactors ; and those who enable the successful and profitable cultivation of our desert and seemingly desert lands, which only want an abundance of water to make them laugh with a harvest when tickled with a hoe, are entitled not only to the gratitude of the nation but to the material success which they will no doubt gather from their enterprise and foresight. Irrigation is now a branch of study at some of the far western colleges ; and improvements in the manner of its accomplishment are sought for with eagerness

and applied at a rate which shows how truly their benefits are appreciated.

Professor Hilgard, director of the Agricultural Experiment Station at Berkley, California, says that the under flow of the great gravel beds in the southern part of California is proving to be of increasing importance as a source of irrigation supply. These gravel beds are natural storage reservoirs which may be emptied and replenished, with due regard to the rainfall and drainage.

Irrigation in the Western States is now being done by straight rather than by curved channels; and many of the old curved ones have been straightened; the channels being checked up so as to give a uniform velocity.

Instead of the ordinary wooden flumes used in mining districts for irrigation in this country, it is purposed to use a flume of galvanized iron, with its upper edge stiffened; the flumes to be nearly circular in shape and supported in cast iron brackets placed in timber supports.

South Dakota is talking up irrigation in a public way; the State investing this year $200,000 in artesian wells. The farm in which a well is located must deed one acre about the well to the township, and right of way through the farm, so that the water can be delivered to the other farms.

Spouting wells have been bored in Washington;

and it is expected that thousands of acres of arid land may be reclaimed in Central Washington by this means.

WATERWORKS.

In a compound plunger hydraulic pump by Woakes, the novelty consists in employing the almost unlimited pressure obtainable from a high column of water (augmented if necessary by a hydraulic ram or press at the top) to work a small diameter piston or plunger at the bottom of the shaft or well. The down or working stroke of the ram is thus effected; the up or non-working stroke is by a small water wheel or other engine. The same principle might be used to compress air in the bottom of a shaft.

The American Waterworks Association committee on standard specifications for cast iron water pipes has issued a report. Among other items, the pipes must stand 300 lbs. per square inch for all sizes less than 12 inches in diameter, and 250 for all above this size; and should be hammer-tested with a hammer weighing three pounds, and having a 16-inch handle. Any pipe varying 10 per cent. in thickness is to be rejected.

The firm of Henry R. Worthington reports that a very marked departure in large waterwork plants is the increase in the number of vertical engines coming into use.

At the waterworks in Utica, there is employed an aëration system, consisting of a series of vertical jets forming a large fountain.

Merryweather has brought out a hydraulic sewer-flusher, consisting of a length of iron pipe closed at one end while the other is fitted with a coupling for attachment to a hose. A series of jets arranged around the circumference of the pipe, which latter is dragged through the sewer, sprays and cleanses the walls.

The weir keepers on the Seine and other French rivers have an automatic flood alarm, consisting of a float one foot in diameter, fixed at any desired distance from the weir and rising with the water level. When the height of the water reaches a certain point, bells are rung by electric arrangement at the weirs down stream, thus warning the keepers to look out for a flood.

Stechner has invented an instrument by which the profile of a river bed can be taken automatically from a boat at the rate of four to six miles per hour. The apparatus consists of a curved arm, hinged at its upper end and so long that the lower curved part trails on the bottom of the stream. The deeper the stream the greater the inclination of the arm ; and the variations may be registered on a rotating drum. On the Elbe soundings were made over 297 miles in ten days.

A Dodd water wheel of 24 inches diameter has been tried under a head of 158 feet with a one-inch nozzle and no governor ; being much like the Pelton wheel except in the shape of the buckets, which have their corners curved downward, so as to partly surround the nozzle. Its efficiency was from zero at 1500 turns to 86 per cent. at 725 turns.

Durozoi has devised an apparatus of the ram kind which can use a minimum head of water and can force the liquid in a single jet of pipe, and can even take up water by suction. The water enters a cylinder which has a valve in its bottom; when the velocity of the water is at a certain point it closes the bottom valve and raises a piston above the cylinder; this piston acting upon the piston of an ordinary suction or force pump.

MARINE ENGINEERING AND SHIPBUILDING.

THERE was a time within the memory of many of my readers when shipbuilding and marine engineering had no connection; when indeed the science of Naval Architecture was a yet unbroached subject. A record of progress in shipbuilding in those days need not have been associated with a chronicle of any advance in steam engineering or in the science and art of iron and steel construction. But in these days of floating war monsters and peripatetic caravanseries of the great deep, it is practically impossible to consider one of these topics without devoting more than a mere passing glance to the others. Hence it is that the titles "Shipbuilding" and "Marine Engineering" have been treated together; although as far as possible matters relating merely to outlines of the hull or to peculiarities of rigging have been kept apart from those which included items of armament or of motive power.

Under the same general heading, too, it has been considered desirable to place some short records of recent achievements in the way of rapid transit across the great waters; and of special endurance of machinery in voyages involving the semi-circumnavigation of the globe almost without a stop.

NEW TYPES OF VESSELS.

A recent Clyde-built iron ship, *La France*, is the largest sailing vessel afloat. She is 375 feet long, 49 feet broad, and 33¾ feet deep. Her after mainmast, which is the largest of the five, is 167 feet above the deck. The length of the lower yards is 82 feet, of the upper from 75 feet to 77 feet. Her bowsprit is 50 feet long. The fifth mast is said by the captain to assist the working of ship greatly, as she tacked very easily. On her first voyage, which was from Cardiff to Rio Janeiro, she reached a speed of 12½ knots an hour. She was then laden with 6000 tons of coal.

It is worthy of note that during the past year there have been built upon the Clyde two centerboard yachts, of the American type, modified by G. L. Watson. The stem has a concave outline; the bow is of canoe type. The center board has the outline of a half moon with the lower limb considerably flattened.

The Herreshoffs have built a novel craft. From the fact that the peculiar construction of the keel would not admit of its touching the floor of the shop,

the boat was hoisted in mid-air by derricks and lowered into the water thereby.

The boat is 25 feet in length on the water line and about 39 feet over all. She is seven feet beam and has for her keel about 875 pounds of iron and two tons of lead. Her stern is very similar to that of the *Gloriana*, and has an overhang of about 15 feet. She is a single-sticker without a bowsprit, and will only carry a mainsail and jib. The keel is nearly square from the side view. It is of iron, while on the bottom are two tons of lead molded into the form of a cone and attached to the iron, making a knife-blade keel or center-board. Without this load of iron the hull of the craft looks like a dory.

The boat was probably built as an experiment, and if it is successful a larger one will probably be built. There is no cabin, a roomy cockpit being at the stern that will accommodate about five persons.

The *Dilemma* on her trial trip is said to have showed wonderful speed.

Mr. Thomas Clapham has built a boat with a center-board and no keel or outside ballast, but with false bilges, to give her stability. The false bilge is immersed only when the boat is heeled, and, although it does not add to her light displacement, it gives her great sail-carrying power. The bilge will be open to the cabin inside, and can be utilized for locker room. The boat is to have jib and mainsail with no bowsprit. The principal difference between this boat and the *Dilemma* is that in gaining stability Mr. Clapham depends upon the peculiar shape of the bilges, while Mr. Herreshoff pins his faith to a lump of lead hung from the bottom.

FAST TORPEDO BOATS FOR BRAZIL.

A torpedo boat made by Messrs. Thornycroft & Co., of Chiswick, for the United States of Brazil, is 150 feet long by 14 feet 6 inch beam, and in that respect is similar to the vessels recently built by the same firm for the Argentine Republic. The armament, however, is somewhat different, there being four torpedo guns suited for the 14-inch Whitehead torpedo, instead of three suited for the 18-inch torpedo, as in the Argentine boats. Two of these torpedo tubes are mounted on racers on deck, and two under deck in the bows, arranged not in the ordinary way, but with gear enabling them to be protruded through doors in the skin of the boat. These doors when closed form a surface continuous with the skin of the vessel, thus presenting no obstruction to the seas and lessening the broken water and the spray which is so easily illuminated by the electric light. When the torpedo guns are run out the torpedo is guided beyond the line of the stem, thus obviating the risk of deflection arising from the pressure of the issuing gases between the torpedo and the skin of the ship. In addition to this armament, the little vessel carries two three-pounder quick-firing Nordenfelt guns, mounted on recoil carriages. The machinery consists of two sets of triple compound engines, supplied with steam by two Thornycroft water-tube boilers. The trial trip consisted of two parts—first, a series of six runs on the measured mile, with a load of 19 tons on board, during which a speed of 25 knots was guaranteed by the builders ; and secondly, a continuous run of two hours' duration, during which a speed of 24 knots was

guaranteed. The results of the six runs were as follows:

	Knots.	Mean Revolutions per Knot.
First run, with tide	27.692	1,065.5
Second run, against tide	23.529	1,289
Third run, with tide	28.346	1,064
Fourth run, against tide	23.377	1,290.5
Fifth run, with tide	28.346	1,062.5
Sixth run, against tide	23.529	1,282.5

The mean of these speeds computed by the Admiralty method being 25.858 knots, Messrs. Thornycroft's guarantee was more than fulfilled. The mean number of revolutions required to do a knot was found to be 1,165.4. The speed attained on these runs was the more satisfactory, in that it increased gradually throughout, the mean of the first pair of runs being 25.610 knots, of the second pair 25.861 knots, and of the third or last pair 25.937 knots, or practically 26 knots. At 1.18 P.M. the vessel was put upon her two hours' run, and at 3.18 it was found that the mean number of revolutions of the screws amounted to 59.174, which, being divided by 1,165.4, the number required to complete a knot in still water, gives a distance of 50.775 nautical miles, or 58.4 statute miles, covered in the two hours. This showed an average speed of 25.387 knots, which, it is claimed, is the greatest distance ever run and the highest speed maintained by any vessel in the time. During the run steam was blowing off from both boilers and the pressure of 210 pounds per square inch was maintained with ease, there being an air pressure in the stokehold of only 1½ inch of water.

A THIRTY-MILE-AN-HOUR BOAT.

The *Bathurst*, one of six torpedo boats built by Yarrow & Co. for the Argentine Government, is 130 feet long, 13½ feet beam, 76 tons displacement, with 14 tons load ; has 1500 square feet heating surface of boiler, makes eight tons of steam per hour at a pressure of 200 pounds, and consumes only 2½ pounds of coal per horse power per hour. The engines are four-cylinder quadruple expansion, of 1230 indicated horse power ; and the average speed of two hours' run is 24.426 knots, or 28.1 statute miles per hour. The maximum speed over a measured mile was 26.086 knots, or a little over 30 miles per hour.

BRITISH TWIN-SCREW TORPEDO BOAT.

The British Admiralty has intrusted Thornycroft & Co. with the construction of a twin-screw torpedo gunboat, 230 feet long by 27 feet beam, and which will have a total displacement of 810 tons when fully equipped and ready for service. The principal difference between this vessel and the others of her class is that she will be fitted with the Thornycroft boiler, and that the indicated horse power is to be 4500 instead of 3500, as in the case of the vessels fitted with the "marine locomotive" type of boiler.

NEW STEAMER FOR THE CONGO.

In the early part of 1891 Messrs. Thornycroft & Co. were intrusted by the Baptist Missionary Society with an order for a new steamer for mission work on the Congo. The vessel, now named the *Goodwill*,

is of the same type as the *Peace*, which was built for the Society by Messrs. Thornycroft in 1881. The *Peace*, it will be remembered, was recently forcibly requisitioned by the Congo Free State, she being the only craft on the river which had a sufficiently light draught (1 foot) for their purpose.

To avoid the possibility of being again in the unpleasant predicament of being without a steamer with which to maintain communication with their brethren at distant stations, the Society decided to place another steamer at Stanley Pool.

After due consideration they decided on the screw turbine system, the weight of the machinery being very small as compared with paddle engines of the same power, an important consideration when the cost of overland transport is so serious.

The new steamer is 84 feet long and 13 feet beam, and draws two feet two inches when laden with cargo.

On the official trial made on the Thames in October the vessel obtained a speed of ten miles with full load on board. The *Goodwill* is fitted with cabins fore and aft and affords ample sleeping accommodation for eight persons. It has a pilot house, chart table, and steering wheel on the upper deck.

The missionary, Rev. Geo. Grenfell, who has superintended the construction of the vessel, lays great stress upon a special feature of the design, which is that from his position on the upper deck, he can, by means of levers, drive the engines of the vessel; having at the same time under his eye the steersman and fireman. The vessel is fitted with the Thornycroft water-tube boiler, a type which was originally adopted for the *Peace* on account of its portability.

The *Goodwill* has been designed and built so that it can be taken to pieces and packed into 64-pound parcels (the load of a native), and from 1000 to 1200 native porters will be required to carry it from the coast to Stanley Pool (a distance of about 230 miles), there to be re-erected and launched.

DOUBLE DECK PROPELLER FERRYBOAT.

The Pennsylvania Railroad Company's new double deck propeller ferryboat *Cincinnati* is the first double deck propeller ferryboat to appear in New York waters.

Some of her dimensions are as follows: length over all, 206 feet; length molded, 180 feet; length on water line, 202 feet; beam over guards, 65 feet; beam molded, 46 feet; depth amidships, 17 feet; draught, ten feet three inches; displacement, about 841 tons. The engines were built at the Pennsylvania shops at Hoboken. There are two compound steeple engines connected directly with a shaft running the entire length of the boat. With 120 revolutions a minute, the engines are expected to develop 1000 horse power, with a speed of twelve knots an hour. The engines have Canfield balanced valves.

The two boilers are 16 feet long, ten feet diameter, and have 100 square feet grate area. They carry a pressure of 100 pounds, but have been tested to 160 pounds. There are two corrugated furnaces in each boiler. The propeller wheels are eight feet six inches diameter, with 11 feet pitch. The boat has a steam steering gear, with two engines, one in each end of the boat, and a hot air heating and ventilating system. The light is furnished by one dynamo of

175 lights of 16 candle power. In addition there is a small engine and dynamo to light the interior of the hull in the daytime, and this will be connected with the signal lamps to be used in emergency, or in case of accident to the main lighting plant. Watertight collision bulkheads are provided throughout.

FAST FISHING STEAMER.

A twin-screw steel steamboat for the fishing trade, being constructed by the Harlan & Hollingsworth Co. (Robert Grimshaw, supervising engineer), is 230 feet long, 32 feet beam, 40 feet width of deck, 9½ feet extreme draught, with triple expansion engines and every appliance which science and experience can suggest, for good speed, ease and steadiness of running, comfort of passengers and convenience of all concerned. Her guaranteed sustained speed is 18 miles per hour through the water, with 900 passengers and 40 tons of coal. The engines are of the condensing type with independent circulating pumps, triple expansion, with 18, 26, and 40-inch cylinders, 22-inch stroke, receiving steam at 160 pounds boiler pressure and making 155 turns per minute, developing at that speed 1250 H. P. The lines of the hull give speed, carrying capacity, and stiffness. The upper house is set inboard about four feet all around to give space for the fishermen. Towing bitts will enable the *Al. Foster* to take care of any disabled vessel which she may encounter; while ample coal-carrying capacity will make her suitable for long coastwise journeys.

The White Star cattle steamer *Nomadic* is a twin-screw steel vessel of 5750 gross tons capacity, 460 feet

log, 45 feet beam, 35 feet deep. The three decks upon which the cattle are housed are cemented over to form a water-tight floor within which connecting gutters are sunk for drainage. Footholds for the animals are provided by heavy wooden strips lengthwise of the vessel, and crosswise at fixed intervals. The cattle are separately stalled, and 1200 can be carried. The engines develop 3400 horse power at 65 turns. Fresh air is supplied and the foul air removed by fans at the rate of 80,000 cubic feet per minute.

The first screw ferryboat on the Pacific coast will be run between San Francisco and Sancelito. It will have three decks and will accommodate 3000 people.

The largest turret ship in the world was launched last year at Chatham, England; being *H. M. S. Hood.* Her floating weight is 7500 tons, length 380 feet, breadth 75, draft of water 26 feet forward and 28 aft, displacement 14,150 tons, indicated horse power 13,000, speed in knots 17½; armament four 13½ inch breech loading guns in turrets, ten six-inch quick firing guns, ten six-pounder quick firing guns, nine three-pounder quick firing guns, twenty-four torpedoes and boat, field, and machine guns. The cost will be about $4,500,000.

The steam launch *Norwood* made, on a public trial, a mile in about two minutes 12 seconds, or over 27 miles per hour, when the safety valve spring gave out, lowering the pressure.

The *Vamoose* made a similar test over a measured mile, covering four miles in 2:50, 2:30, 2:30, and 2:35,

respectively, or an average of 2:36¼. This is an average of $23\frac{1}{8}$ statute miles an hour for four miles.

IMPORTANT NEW VESSELS.

Work has been begun on the big Cruiser No. 6, at the Union Iron Works, San Francisco. She will be the largest vessel ever built on the Pacific coast, being 340 feet long, 53 feet beam, and drawing 21½ feet when ready for sea, on a displacement of 5500 tons. The contract calls for 20 knots per hour for four consecutive hours, with 13,500 horse power engines. The coal-carrying capacity is 1300 tons, which will enable her to steam 13,000 miles at a ten-knot speed. She will have a steel deck, twin screws, and schooner rig. In the main battery there will be four eight-inch breech loading rifles, in two barbettes, and ten five-inch rapid firing guns. There will be also fourteen seven-pound and six one-pound rapid firing guns, and four Gatlings ; besides six torpedo tubes.

The coffer dams of Cruisers 9 and 10, building at the Columbian Iron Works, Bethlehem, will be filled with cellulose. The living-rooms and store rooms will be painted with cork-paint, which keeps the ship dry in warm moist climates.

The first steel vessel ever built on Lake Michigan was launched March 14, in Chicago. Her length is 308 feet, beam 40, depth 24½.

By August 1, 1893, Cramp & Sons of Philadelphia are to deliver Cruiser No. 13, at a cost of $2,690,000. She is to be much like No. 12, and is designed for a constant speed of 22 knots per hour with

20,500 horse power. Her coal-carrying capacity is to be 2000 tons, which would enable her to steam around the world at a ten-knot rate. She is to have three screws, one center and the others forward a little, to one side and above. The length of hull is to be 400 feet on the mean load line, breadth of beam 58 feet 2¼ inches, depth of hold from top of main deck beams to inner bottom 29 feet 1⅝ inches, displacement 7350 tons. There will be eight double-ended main boilers, in four water-tight compartments, and two single-ended auxiliary boilers on the berth deck. The working pressure will be 160 pounds. There will be three sets of triple expansion vertical inverted cylinder engines, with cylinders 42, 59, and 92 inches diameter, and 42 inches stroke. There will be a sloping armored deck, four inches thick near the sides and two and a half in the middle; and next the ship's side for its full length, a five foot wide coffer dam filled with woodite, or other water-excluding substance. The battery will be one eight-inch, two six-inch, and twelve four-inch breech-loading rifles; sixteen six-pound and eight one-pound rapid firing guns, four Gatling guns, and four torpedo-launching tubes.

The steamer *Scott*, of the Cape Mail Line, has smoke stacks 120 feet high above the grates, giving a draught of three-fourth inch of water pressure. Her speed is 19 knots. Her length is 502 feet over all, 460 feet on the water line, 54½ beam, 37½ deep; tonnage 7000; draught 23 feet with 2800 tons of coal. This vessel could clear the floor of the Brooklyn Bridge, which is 119 feet above high water.

An entirely new type of vessel, called the whaleback, has made its appearance in our Western lake waters, being in the shape of tow barges and steam propellers. They are round decked, flat bottomed, and ended up like the pointed end of a cigar; but the hawseholes in the bow increase their resemblance to a pig, which is not diminished by their wheelhouse or turret, and by the railing that runs along their tops. The water washes over them, not against them. They have made successful voyages across the Atlantic, loaded with wheat.

Alexander McDougal, of Superior, Wis., is the inventor, and the American Steel Barge Company owns the patents and the plant.

The steam cruiser 25 *de Mayo*, built for the Argentine Government, showed on trial with natural draught 21.237 knots per hour for six hours, developing 8700 indicated horse power. With forced draught the mean speed was 22.43 knots, and the horse power 13,800. With her full supply of coal she could steam 2000 knots at full speed, with natural draught; and at the most economical speed, 900 to 1000 knots.

The new vessels building for the Cunard Co., will, it is reported, be ready by the summer of 1893, and their speed is guaranteed at 21 knots in the open sea. The Fairfield Co., which is to build them, offered vessels to make 22½ knots, but this would be at the sacrifice of passenger room. There will be in the new vessels accomodations for 600 first-class passengers, or nearly one-third more than the *Teutonic* or *Majestic*.

Rumors are current that these new vessels are to make 22 knots, with a spurting capacity of 24.

RAPID OCEAN PASSAGES.

The Hamburg American steamer *Fürst Bismarck* passed Sandy Hook September 10, having made the passage between Needles and that point in six days, 12 hours, 58 minutes, the fastest passage yet made between New York and Southampton. Her daily runs were 411, 451, 450, 452, 460, 464, 360 miles. This ship made the trial trip from New York in six days, 14 hours, and seven minutes from Southampton, breaking the record not only in this line but for maiden trips. The distance was 3086 miles; the average speed 19¼ knots per hour. The best day's run was 498 miles.

The *Majestic* completed June 10 a voyage that would have been the best on record had she gone over the same course that the *City of Paris* did when she made her record run of five days, 19 hours, 18 minutes. The *Majestic* took a southerly course of 2850 miles, and made it in five days, 22 hours, 20 minutes; her average speed being 20.023 knots per hour. Her best day's run was 502 miles.

August 5, the *Majestic* came into New York, having made the trip westward in five days, 18 hours, and eight minutes, the distance logged being 2777 knots. For one hour of the time only the port engine was running. The two engines developed 19,500 horse power, and the screws made an average of 78 turns per minute; the coal consumption being said to have been only 220 tons a day.

The White Star liner *Teutonic* has reduced her record to five days, 21 hours.

As an instance of rapid traveling around the globe, the steamer *Empress of Japan* left Yokohama August 19, and made the voyage to Victoria, B. C., in nine days, 19 hours, and 20 minutes. Her mails were brought by a special Canadian Pacific train, leaving Victoria August 29, and reaching Rockville, on the St. Lawrence River, in 77 hours, 20 minutes ;—2803 miles, at 36 miles an hour. The New York Central Railway took them to New York, 353 miles, in six hours, 58 minutes, or over 50 miles per hour. Ninety-five miles of this run are said to have been made in 90 minutes. Some of the mails arriving at New York were transferred to the steamer *City of New York*, which made the voyage to Queenstown in five days, 22 hours, 50 mintues ; thus making the passage from Yokohama to Queenstown in 20 days, about 10,000 miles of distance, and considerably more than half around the world in these latitudes.

The 11,000 mile sailing-ship race from Calcutta to Scotland, between two Scotch sailing vessels, was won by the four-master *Trafalgar* of 1696 tons, over the *Ardencraig* of 2072 tons.

A large steamer, the *Tekoa*, has steamed at full speed 12,059 nautical miles without even slowing down. Her carrying capacity is 6250 tons dead weight. She has triple expansion engines 27, 43, and 73 by 45 inches. She had to stop for coal at Teneriffe, otherwise she would have made her full run from London to Auck-

land, 13,772 miles. The engines were in good condition on arriving. The average speed from London to the Australian coast was ten knots; from London to Auckland 58 days, two hours.

Bessemer proposes to make plates for shipbuilding thicker at their edges, this being possible by his fluid process of rolling. Such plates were used on the Midland railway years ago.

The dynamite cruiser *Vesuvius* is said, by the authorities, to have failed; and they recommend that she be turned into an ordinary torpedo boat. She is not fitted as a gun platform even if the dynamite gun was a success; her magazine and a great portion of the length of her guns are exposed to destruction by shells, and she steers badly.

A screw vessel has been built in Scotland, having sheer legs on deck, so as to enable the vessel to be independent of dock sheers in loading or unloading.

Beaumont proposes screw propulsion with non-reversible engines, by a feathering screw; but the principal objection to the plan is that a right-hand screw blade when turned 180° about its axis is right-handed as before.

An aluminum boat has been tried on Lake Zurich. It weighs half a ton, being about half the usual weight of a boat of the same size. It carries eight persons, and with a two-horse petroleum motor makes six miles an hour.

During the past year there has been brought into use a type of compound independent air and circulating pumping engine in which the air pumps are single-acting and vertical, worked by a beam operated by a rock-shaft from the direct-acting pumping engine, the high and low pressure steam cylinders being worked by a Blake adjustable valve-gear while the pump is in operation; the water valves being of extra large area to permit of high speed—250 feet piston speed per minute having been reached.

The steering gear of the steamship *Teutonic* is of a novel character. In its main feature it resembles a cast steel horizontal spur wheel, 18 feet in diameter, movable about the rudder head, and connected to a tiller, keyed on the rudder head, by arms made up of layers of flat springs. These take up the shock of the sea. The spur wheel is worked by steam steering engines.

Experiments in great variety have for some time been going on in the various navies of the world with anchors of different kinds, and among those that have been tested with specially favorable results is one now in use aboard several of the new Goverment cruisers. This anchor, which is made of cast steel, has its crown and flukes rotate on a pin joining them to the shank head, the construction being such that if the pin should break, the anchor will still hold and perform the required function, while the shank cannot draw out and the anchor be lost, as the shank head is enlarged and works against the round shoulders inside the crown. When let go from the

ship, in striking the bottom it "bites" immediately after strain is brought upon the chain, this being irrespective of any particular position in which it may chance to strike, owing to the shape of its crown. Both of the flukes engage at once, thus securing what is the great desideratum, namely, a tremendous holding surface.

Mr. Beauchamp Tower has invented an apparatus for providing a steady platform for guns, etc., at sea. The platform is suspended on gimbals on the top of a hopper-shaped pedestal, standing on a round, hollow pillar, rising up from the vessel's deck. The part that in ordinary gimbals has a ring, has here two gaps cut for the gun. One end of each arm from the gimbal moves in a bearing attached to the top of the hopper-shaped pedestal, this bearing having all the motions of the ship, the other end forming a bearing on which the platform rests. These arms are hollow, and the bearing contains water-tight oscillating joints, so that a supply of high pressure water can be sent through the hollow gimbal arms to the platform to work the mechanism. Projecting down the platform, and attached to it, are four cylinders, one at each corner; out of the top of each projects a ram which works freely, not water-tight, in a collar at the top of the cylinder, each ram being attached by a connecting rod to the pedestal. If water under pressure enters in one of the cylinders, it would press the ram out of the cylinder, and so cause the platform to be inclined in the gimbals. There being four cylinders, the platform can be inclined in any direction. There is a water-tight bearing to diminish the friction.

The North German Lloyd steamers use as an anti-corrosive for ships' bottoms, Rahtjen's composition, the same as is used by the British navy. The cost of painting a vessel of 1800 tons register two coats is only about $250, the vessel running a year without docking. The compound dries as quickly as applied, and the vessel can be put into the water at once it is painted.

Lacquering ships' bottoms to prevent them from corroding has been tried with success in Japan. Twelve hundred square feet of the bottom of the cruiser *Fuso-Ken* were treated, and after fourteen months the condition of the bottom was so good that the remainder was similarly treated. Three years after the first treatment the vessel was docked again and the bottom found to be in good condition.

The method of application is to scrape the bottom of all yellow rust and impurities not formerly adherent ; then inclose the bottom by canvas screens up to the water line, to enable the temperature to be raised above freezing in winter. The lacquer is applied with a wooden spatula and spread with a soft, flat animal's-hair brush. One man can go over 500 square feet in eight hours. The first coat is nearly pure lacquer ; but subsequent coats contain mica and kaolin. After three to five coats a special anti-fouling lacquer is added, this containing a poisonous mercurial salt. The whole process takes from six to ten days and costs thirteen cents per square foot.

Labat, of Bordeaux, has constructed three slips for the broadwise docking of vessels, at Bordeaux, Fou

Tchiou and Rouen, each comprising three parts, an inclined.plane, a cradle, and a tractive apparatus. That at Rouen is 90 meters long, and can receive vessels 95 meters in length, and weighing 1800 tons. The slope is one in five ; the width in the hauling direction 31.3, requiring from two to five hours to ascend, according to the weight of the vessel. The cradle may be divided lengthwise so as to take two vessels of unequal length, or one long one. The traction is by chains fastened to movable pulleys, to which there is attached a compensating cable, so as to give an equal strain to all the chains. The motor is of 50 net horse power.

The Schjott oil distributer on a vessel launched by the Laxevaag Ship Building Co., Norway, consists of a plate iron reservoir, from which a pipe proceeds along the side of the vessel as near the water line and as close to the bows as possible. This may be connected to the water closet pipe, which is both cheap and practicable. In the reservoir is a valve which can be opened at will more or less, and whereby the distribution of oil can be regulated. On opening the valve the oil flows with great regularity until the last drop is used.

Still another plan has been brought forward—this time by an English ship officer—for spreading oil on stormy seas with a view to abating their violence, any kind of crude oil being adapted to the purpose, though seal oil has the preference, and, as the apparatus is designed to distribute the oil in a uniform and continuous flow from the bows of the ship, the greatest

possible economy and effectiveness are claimed to be secured. The oil is contained in a tank connected with a cylinder placed in the forepeak of the ship, and in such a position that it will be slightly above the water line ; from the cylinder two small copper pipes lead out through the bows on either side, and the oil is allowed to pass just over the water; and although the outlets of the pipes are but the sixteenth of an inch in diameter it is asserted that the amount of oil which thus escapes is sufficient to bring to a state of calmness the most turbulent waves. It is in the cylinder that a steel piston works, forcing the oil several feet beyond the bows—about seven gallons of oil in the tank and five in the cylinder lasting, it is said, four hours, with both jets steadily running.

LOCOMOTIVES.

These are the days of the iron horse; and as much attention is being paid to his development in speed, endurance, and economy of keeping, as the most enthusiastic lover of the equine race pays to lowering the record each year. Those in authority have at last come to the conclusion not only that no one type is best for all conditions, but that perhaps there is no one type yet produced which is the best for any one set of conditions. Accordingly we see the American models tried in more or less modified conditions abroad, and the English and Continental types borrowed from in the endeavor to improve the American locomotive. At present the competition is most eager, particularly in the direction of compounding.

AMERICAN COMPOUND LOCOMOTIVES.

The past year has been noteworthy in this country for having been a period of great development of the compound locomotive, one establishment having received orders for over 100 since January—four of these orders coming from a single railway company. All these were of the Vauclain type, which has four outside cylinders, the high pressure being above the low on each side, and the valve chest for each side being inside and alongside of the cylinders. The valve is of the piston type, consisting of a hollow block with cylindrical rims, fitting in a hollow cylinder with apertures registering with the rims of the plugs, leading to and from the ends of the cylinders from the steam pipe and the exhaust pipe. The steam enters the high pressure cylinder and drives the piston therein, on the return stroke passing through a circular groove in the center of the valve, and being discharged through the exhaust port and the exhaust pipe. The same operation takes place in both ends of the cylinder. The valves are fitted with simple ring packings inserted by springing them into grooves in the plug. A committee of the Franklin Institute reports that there is very little force required to reverse the engine with the throttle open and full steam pressure upon the valve. The exhaust seems to be less noisy than with the ordinary locomotive. The engine rolls easily when cutting off close or with the reversing lever near the central position, avoiding the resistance of the piston to motion experienced by the ordinary locomotive in like adjustment. The engine in active service has shown economy of fuel and di-

minished requirement for feed water, the average fuel saving in round trips between Philadelphia and Washington being 15 per cent. as compared with the best procurable standard engine. It will be noted that this type of compound engine takes steam at once from the high pressure to the low pressure cylinder, the two pistons being connected and moving together, no receiving chamber being needed.

The Baldwin Works are trying a two-cylinder compound with an intercepting valve by Vauclain.

The Schenectady Works have built a number of compounds with the first form of Pitkin intercepting valve, and are now working on some with an improved type of valve.

The Pittsburgh Works are perfecting a starting gear.

The Rogers Works have an intercepting valve which they are ready to put on any two-cylinder compound for which they may have orders.

The Brooks Works have put out a compound Mogul with two cylinders and a new intercepting valve.

The Pennsylvania Railway has completed drawings for two-cylinder compounds with Lindner starting gear.

The Old Colony Railway has finished a two-cylinder compound on the Dean principle, to carry 180 pounds, to be tested against a simple engine with 200 pounds pressure designed by Mr. Lauder.

The new compound engine of the R. I. Locomotive Works, at starting, works with single expansion with four exhausts per revolution, then automatically changes to compound. When the throttle is open,

steam passes through the high pressure cylinder in the usual manner, also to the intercepting valve, the piston of which is forced to close the passage to the low pressure cylinder and let steam pass into the latter through a reducing valve. The piston of the intercepting valve will automatically change to such position as to allow steam to pass from the receiver to the low pressure cylinder, when the pressure in the receiver is brought up to the desired point by the exhausts from the high pressure cylinder. The engine is changed from compound to simple at will by the engineer, by opening a valve connecting the receiver to the exhaust pipe, which allows the exhaust for the high pressure cylinder to pass through the exhaust nozzle in the usual way.

FOREIGN COMPOUND LOCOMOTIVES.

F. W. Johnstone, Superintendent of Motive Power on the Mexican Central Railway, where coal costs about $11 a ton, has brought out a compound locomotive in which the high pressure cylinder is 14 inches in diameter, and the low, in which it is inclosed, 30¾, giving the latter a net area equivalent to that of a cylinder 24½ inches in diameter, and making the ratio three to one. The stroke is 24 inches, and the two low pressure piston rods are coupled to the same crosshead as the high pressure rod. The valve distributes steam to both the high and the low pressure pistons, requiring but one valve, driven by the ordinary link motion. The outer part distributes steam to the high pressure cylinder, and the inner section to the low, the inner section being carried by

the outer and having one inch less travel to retard the point of cut off of the low pressure cylinder, and reduce the compression in front of the high pressure piston. When in the high pressure cylinder the admission is cut off at nine inches, the low pressure continues open up to 17 inches ; but the compression on the high pressure piston which would begin at nine inches, if both valves had the same travel, does not take place until 17 inches in the high pressure and 19 in the low pressure cylinder. A special starting valve enables live steam to be sent through a reduced opening to the low pressure cylinder, putting the high pressure piston in equilibrium and letting the low pressure piston act with greater starting power than in an ordinary high pressure engine.

A compound locomotive recently designed for the Grand Trunk Railway of Canada is on the lines of the Worsdell and Von Borries system, with the Von Borries intercepting valve. The cylinders are 18 and 28½ by 26 inches. The link hangers are of different lengths, so that .04 cut off in the high pressure cylinder corresponds to 0.5 in the low ; and the latest cut off running forward is 0.75 in the high pressure cylinder and 0.8 in the low.

F. W. Webb's "Greater Britain" compound locomotive has two independent driving axles, one driven by a pair of high pressure cylinders, outside, and the other by a single low pressure cylinder inside of the frames, the cylinders being 15 and 30 inches by 24-inch stroke. The engine is in the matter of tractive power equivalent to a non-compound locomotive 21 by

24 inches. There are four 85-inch driving wheels, and in front a pair of 49½-inch leading wheels with radial axle boxes, back of them coming a pair of trailing wheels with a lateral play of one-half inch. The high pressure cylinders have the ordinary curved link with the valve gear outside the frames. The low pressure cylinder has Webb's single eccentric motion. The boiler has a very long barrel to permit both the driving axles to be put under it; but the tubes are in two lengths with a combustion chamber between them; the first set being 70 inches long and the second 121 inches. There are 156 tubes in each set, the first set being copper and the second brass; tube diameter 2⅛ inches, fire box surface 120.6 square feet, combustion chamber heating surface 39.1, front tube surface 853, back tube surface 493, total 1,505.7. Grate surface 20.5 square feet; steam pressure 175 pounds; weight of the engine 52 gross tons two cwt. of which 15 tons ten cwt. are upon each driving wheel. The average speed between Rugby and Euston was 44.59 miles per hour; consumption of coal per mile per ton of train 1.42 to 1.719 ounces; total train weight 382 tons, of which 305 tons were in the coaches, 52 in the engine, and 25 in the tender.

A compound engine on the Northern Railway of France has four driving wheels connected and two high and two low pressure cylinders, the large cylinders being between the frames. This road now has four kinds of compound engines. Besides the one just described, which has parallel rods, it has a Woolf with tandem cylinders, a three-cylinder with parallel rods, and a four-cylinder without parallel rods.

Russia is using compound locomotives. There are thirty-two on the Grazi-Tsaritsin Railway alone in South Russia.

LUMBER LOCOMOTIVES.

In the operation of the lumber railways in the Alleghany Mountains of Northern Pennsylvania, there are employed locomotives having three vertical cylinders, driving a horizontal shaft, geared to all the wheels, tender included. The shaft is jointed so that the longest rigid wheel base is 56 inches. Such an engine uses the whole weight for adhesions, and at a ratio of one-fourth of the weight of 60 tons would develop 30,000 pounds tractive power.

A new gigantic locomotive on the St. Gothard road is a compound tender and locomotive, with four cylinders, the fuel and water carried by it serving to increase the friction on the rails and the consequent tractive power. The running gear of this long engine is divided into two groups, the six wheels of which are connected with the mechanism belonging thereto. The two motor groups are connected by a joint, and move toward each other horizontally.

A SMOKE-CONSUMING LOCOMOTIVE.

The Chicago and Alton locomotive equipped with the smoke consumer invented by A. R. Cavner does not differ much in appearance from others except in the shape of its smokestack, which is perforated with hundreds of small holes, and in being lighted at night with electricity. Its inventor says that besides con-

suming its own smoke, the device economizes fuel and reduces back pressure to a minimum.

The extension front, extending from the flue sheet to the cast front door, is divided into two compartments by a light vertical partition crossing entirely across the front just forward of the exhaust pipe, thus confining all the heated gases, exhaust steam, etc., in the compartment next to the flue sheet, and having direct communication to the fire box. No change is made in this compartment except that the tips on the nozzle of the exhaust pipe are taken out. The exhaust opening is left full open to the area of opening in the saddle casting, the stack and saddle are taken off, and the stack opening increased to twenty inches in diameter. There is placed over the exhaust a lifting pipe, twelve inches at the bottom and end, tapering to fifteen at the top and forty inches long—a sheet-iron pipe. This pipe, twenty inches in diameter, sets over that, resting on top of the extension front. Over this is the ordinary dome casting. This is perforated with 2000 seven-sixteenths-inch holes extending half around the front side of the casting. On the inside of the twenty-inch pipe there is coiled fifty-two feet of two-inch brass pipe.

The forward compartment of the extension front is used as a receptacle for the mechanism by which the draught is secured and power furnished to run the dynamo. In this compartment is located a pressure blower in such position as to admit of free access to the flue sheet. The pressure blower is connected by friction to a small sixteen-hand power rotary engine, and is also connected direct by an air pipe extending from the front end of the engine back

under the truck of the locomotive to the ash pan. The ash pan and dumpers, having asbestos joints and shutting firmly, make the ash pan air tight. The air from the fan is drawn down through the perforation, and is heated to a high temperature by the exhaust steam and heated gases. The result by this method is that the fire is fanned by a constant blast of seven-ounce pressure, and this air is made hot by the heat that would be otherwise wasted. A portion of this hot air is conducted in pipes from the main air pipe through the ash pan, up through the fuel, and is forced into the flame from the back of the fire box toward the flue sheet. Circling the fire box door are innumerable small holes or air jets. This hot air uniting with the carbon is claimed to complete the combustion, and prevent smoke whether the engine is working or shut off, and whether there is a light or heavy fire, and to prevent gases from passing out of the fire box door. By means of this air pipe the fire box is converted into a gas retort, consuming the carbon and the carbonic oxide gas that would otherwise pass off in smoke.

TUNNEL LOCOMOTIVES.

The approaches of the St. Clair tunnel will have a grade of 105 feet per mile, and to work on them there have been built some very heavy Baldwin tank locomotives, weighing 195,000 pounds in working order. There are five pairs of drivers, 50 inches in diameter, and no other wheels. The wheel base is 18½ feet; cylinders 22 inches diameter, 28 stroke; boiler 74 inches diameter; firebox 11 feet long, 3½ wide. The rails will be 100 pounds to the yard.

VARIOUS IMPROVEMENTS IN THE LOCOMOTIVE.

A double-latch reversing lever has two latches, one in front of the other and touching, and either of which may be dropped into the notch in the quadrant, thus enabling finer hooking down than would be possible with only one latch.

An audible signal for locomotive cabs, operated by a battery within the cab, warns in case of danger from switches, draw-bridges, etc.

An injector indicator is to call the attention of the engineman if from any cause the injector stops working. There is a valve in the feed pipe just above the level of the water when the tank is full. When the injector is working, the valve is held on its seat by its own weight and by the suction of the injector; but if the injector "flies off," the steam passes down the feed pipe and raising the valve escapes into the cab in two jets sufficient to attract the engineman's attention.

Some German locomotives are being fitted with ash pans which prevent dangers from fires by sparks from the ash pan. The places where the ashes lie are protected from direct disturbance by draft, and so arranged that the wind cannot drive the ashes out. The draft compartment is made separate from the ash-collecting compartment.

A smoke box protector is to save the bottom sheets in "long front ends" which are often burned out. It

is simply a layer of fire clay, over which there is a casting which keeps it in place.

A new brake-shoe hanger permits endwise motion of the beam and shoe so that the latter remains vertical and cannot exert sidewise pressure against the wheel.

A fire box door opener by Hawksworth, applicable to any of the ordinary old-style outside doors, is operated by the fireman's foot pressing a latch extending from the deck, thus opening an air valve which liberates air enough to act upon a piston which swings the door. Closing the door compresses air enough to open it the next time the latch is pressed.

A sand dryer for locomotives consists of a circular live-steam passage around the sand pipe where it leaves the box.

The Southern Pacific Company has imported a plant from England for making briquettes for locomotive fuel. The machinery is being erected at San Francisco.

A check chamber which will permit the examination of check valves while steam is up and keep them at all times from the action of mud, consists of a chamber into which the checks discharge, and which may be cut off from the boiler by a screwed spindle valve. This chamber is attached to the boiler at such a height that the water runs into the boiler by gravity.

Mr. Gustav Lentz of Dusseldorf (late managing director of the Hohenzollern Locomotive Works) has designed a stayless locomotive boiler.

A mechanical stoker for locomotives has been patented by John D. Ward, of Minneapolis. The inner sides of the tender, or coal receptacle, are inclined, and centrally in the bottom is a channel into which there extends the shaft of a feed screw, coupled at its outer end with a similar shaft, which has a bevel gear wheel, meshing into a similar wheel on a cross shaft in the cab, connected with a motor, to feed the coal by an inclined shute into the fire box.

The Chicago and Northwestern Railway has abated the smoke nuisance on many of its locomotives by an apparatus for forcing jets of air into the furnace in sufficient quantities to complete combustion.

The Lehigh Valley Railway is having engines built with steel crank pins, oil tempered and annealed. The same company is having two sets of locomotive tires treated in the same way.

The Manhattan Railway Company of New York is having locomotives made with steel frames slotted out of the solid on the plan of the English; they will also have wrought iron drivers. Just how well a rigid frame will run on an elastic track, time alone will show.

The pistons for the low pressure cylinders of the new Lehigh Valley compound engines are double

plates of cast iron with ribs between weighing less than the pistons for many smaller cylinders, a 30-inch piston weighing only 388 pounds without the rings, or 426 with. A 20-inch piston of this type weighs 214 pounds ; a 28-inch 342 pounds.

The Eastern Railway of France is experimenting with a new type of locomotive boiler, with a double barrel, the lower part being filled with tubes and water, and the upper with steam. The upper and lower shells are connected by three openings with flanged necks between.

The desire of the railway companies for locomotives which shall haul fast trains of 300 tons seems to be best met by the Mogul and ten-wheel engines.

Some of Baldwin's ten-wheel engines are to be tested against "20 by 26" English ten-wheelers in Australia, on the Melbourne express.

A feed-water heater and purifier for locomotives has been tried on the Long Island Railway. There is above the shell a supplemental dome into which the feed water is delivered, falling by a pipe to a mud drum under the boiler, there settling its impurities. As fast as required the water leaves the mud drum and rises by another pipe which passes around the boiler, and goes through a vertical pipe through the center of the supplemental dome to the water space of the main shell.

A sand box worked by air is used on the Burlington road. There is a piston working loosely in a cylin-

der which has a cap with an adjustable screw, that acts as a stop for the end of the piston. A pipe leads from a small valve in the cab near the throttle lever and within easy reach of the engineer. When air from the main air drum is let into the pipe it passes under the piston, which is raised by the pressure until it brings up against a stop in the cylinder cover. When the piston has been raised to this point a small side opening in the piston rod lets the air pass down the center of the hollow piston rod and through the plug valve, the opening in the plug being reduced at the point of the valve. As the air passes through the opening in the pipe it not only blows the sand which is ahead of the 'valve but by suction causes the sand to flow, even if wet. There is no rod connection to the sand box and instead of the usual sand-rod handle there is a small plug valve.

The Baldwin works have taken up the manufacture of wrought iron pistons on the same plan as employed by them for locomotive driving wheels. The 17 compounds for the Central Railway of Brazil are fitted with them.

A variable exhaust nozzle which is being used on the Union Pacific Railway permits the area of discharge to be enlarged. There is a stationary ring with inwardly projecting flat teeth having between them spaces equal to their own area ; next to this stationary ring there is one having similar inward projections which may be brought into line with those on the stationary ring, leaving spaces between the teeth on both rings, or may be brought so as to cover the

spaces between the teeth of the stationary ring, so as to reduce the effective area by the amount between the teeth.

NEW LOCOMOTIVE FUELS.

Italy has commenced to use lignite as fuel on her railways, instead of importing all her fuel. As there are beds of lignite in Italy the change should prove economical for the kingdom. These railways are trying lignite prepared by the Sapori process.

The Oroya Railway and the Molhendo, Arequipa and Pamiapumo Railway of Peru have decided to use fuel oil instead of coal. The first has several locomotives running with the new fuel, and the second has commenced altering its engines. Fuel oil is not crude petroleum but a residuum with a fire test of about 300° Fahrenheit. The amount of oil used is rather less than 50 per cent. of the weight of coal; this is by reason of the greater regularity of feed. In tunnels the oil is a great boon, doing away with smoke and sparks.

Several years' supply of the oil have been contracted for. The burner used is cast in one piece without any movable parts, hence should be less easy to get out of order than that used on the Grazi-Tsaritsin Railway, which has over 20 parts, all accurately finished and fitted.

RAILWAYS—PERMANENT WAY.

EXPERIMENTS in the direction of improving the permanent way of steam and urban railways are less easy to make and test, and the adoption of improvements which have been tested and improved is much less easy of accomplishment, than is the case with the locomotives and rolling stock. But there is no track the constituents of which do not succumb to the continued action of time and traffic, and of course experiments are being made and improvements introduced from year to year; however, advance is more gradual than radical. The tendency seems to be toward the introduction of heavier metal in the rails, and efforts are being made to introduce metal ties and chairs, and improved joints and methods of fastening down the rails.

Thos. C. Clarke, in a paper before the American Society of Civil Engineers, concludes that the only radical way of curing the difficulties with railway tracks is to return to the old form of continuous rail and continuous bearing; steel rails permit of the former. The lengthwise bearer must be stiff enough to carry the load each side of the wheel, so as to limit the pressure to two tons per square foot. The rails must break joint with the bearers; the fastenings must be so that the rails may be quickly removed and replaced by new ones, but must be able to hold for a time a broken rail. The bearers and rails

should be united by light metallic gauge ties; both the bearers and the gauge ties should be easily tamped, and there must be no difficulty on curves.

Flanged rails are being introduced in India instead of the double-headed type, for the purpose of using steel sleepers.

A new railway spike is rolled in plates, having for their cross section the lengthwise section of the spike, thus doing away with the deformation usually caused by making the head on the ordinary spike. The new spike has a sharp edge, and cuts the fibers of the wood as it is driven, allowing their separated ends to impinge closely against the sides of the spike. There is, above the head, an anvil-like projection forming an extra head to receive the blow of the hammer in driving. Six of the new type, as compared with the standard English type, required 25,935 pounds to draw them from pine ties as against 14,235; and in elm 58,850 pounds as against 35,300. To show the power of this spike in holding the rails from spreading, two rails were spiked down to ties—one with standard spikes and the other with the new rolled ones; the two ends of the jack were pointed and made to bear on metal blocks between the rails, and the new spike held so firmly as to crowd the other out.

A new rail joint is a suspended malleable iron girder on ties 12 inches apart. The bed plate of the girder has a camber; its web is carried both below and above the base of the rail, and the portion

of the girder above the bed plate rests against the side of the rail head, making a rail brace to keep the line of the rail ends. The bed plate is a channel for the rail base. The rails are held by clips seizing the flanges, and are bolted under the bed plate, but not in contact with the rails or their vibrating or wearing parts; so that no bolt-holes are necessary in the web of the rail. To prevent rail creeping, lugs are cast in the bed plate of the joint, with corresponding slots in the flanges. There is nothing to resist contraction and expansion of the rail.

Steel ties that were placed in the track of the Chicago and Western Indiana Railway nineteen months ago have been examined by the roadmaster. The track had a very heavy traffic, but the roadmaster reports that the ties not only were safe, smooth, and pleasant to ride on, but were a money-saving device. He also observed that there was less oscillation and vibration in the locomotives and cars passing over them, especially in heavily loaded cars of yielding material, like grain.

The engineer of the N. Y. C. & H. R. Railway reports as the results of the experiments with Hartford steel ties, for over a year, that on the basis of fifty-five cents for a wooden tie and $3.00 for a steel one, there is eight to twelve per cent. saving in the steel.

A continuous railway crossing is a device intended to take the place of the open frog at railway grade crossings, a continuous rail being secured for traffic

in either direction. On a good foundation there lie timbers upon which is placed the frame of the frog: a steel girder, in outline a parallelogram, with its angles conforming to those of the crossing, but at each corner the girder is bent into a loop. Upright in this loop, with its foot in a step firmly riveted to the bottom of the box and its upper end well held, is a five-inch shaft, carrying a cap corresponding in form to the head of the rail. Rotating the shaft causes the cap to complete the rail across the gap in either direction at will. All four of the caps are turned at once, to an equal degree, by suitable mechanism by the operator. Detector bars prevent turning the movable parts of the rail while a train is passing, and no signal can be given until the parts are in proper position.

A new type of street railway rail, which seems better than any other to fulfill the desired conditions, is duplex, each one of the two sections composing it being of T or rather of hammer-head section, the two breaking joint, so that each section is in fact the fish-plate for the other. They are laid in chairs about five feet apart, the webs of each section fitting into slots in the chairs and the latter being connected by steel tie-bars, absolutely preserving the gauge. The cost of metal and of laying are less than for other types of street rail of the same vertical stiffness; the metallic connection between the sections is practically continuous, and the tie-bars may if desired be insulated from the rails so as to permit any system of electric traction to be used with advantage. These rails are laid on Fourth Avenue, New York, below

the Cooper Union, some of them having the chairs laid on concrete slabs, others having them spiked to cross-ties as an experiment suggested on the part of the Company owning and operating the line.

A new double-acting track-drill acts both on the forward and on the return stroke of the lever or handle, this being effected by two bevel gears.

McLain has devised a track cleaner which is a combined plow and scraper for street railways. On an arm depending from the under side of the car floor are pivoted independently two plow beams, to the outer ends of which the blades are fastened by bolts, which extend beyond the blades so that rubber blocks can be interposed between the ends of the bolts and the rear faces of the blades. The plow and beams are raised independently by flexible connections running over the pulleys fastened to the boot leg, to a point above the platform. When the blades meet an obstruction they twist against rubber blocks so that a constantly increasing force is applied to the obstruction, finally depositing the latter to one side of the track, the blades yielding to such extent as to avoid damage.

An American inventor has brought out a system of gearing for use of rack railways, using a rack consisting of a steel wire twisted into a spiral, the wheel having in place of teeth another steel wire spiral attached to its rim and gearing into that on the rack.

The Abt rack railway, which has recently come into prominence, consists in the main of a line with or-

dinary adhesion rails, with an axial rack, consisting of several toothed bars of rolled soft steel, so placed alongside each other that the teeth overlap. The locomotive has two independent motive mechanisms one of which is the ordinary adhesion type, and works continuously, and the other operates only where the racks exist. The toothed wheels consist of as many toothed disks as there are racks, and are carried by axles so spaced that they shall come into gear alternately, and make the meshing smooth. There is a very powerful compressed air-brake, consisting in a reversal of motion, after substituting for the entrance of steam a flow of external air, which is cooled during the compression by an injection of water.

Messrs. Max E. Schmidt and J. L. Silsbee propose a multiple despatch railway, and read a paper about it before the Western Association of Engineers at Chicago. The invention consists of three continuous platforms of which the middle one or car contains seats, and travels just twice as fast as the outer ones; this being accomplished by attaching the cars to movable, flexible tracks resting upon the peripheries of wheels mounted upon suitable axles, so that as the wheels and axles run upon fixed tracks at a certain ratio of speed of the axles, the movable rails and cars attached thereto will move at double the ratio of speed of the axles. It is claimed that a person can step on a platform that is approximately level with the ground and moves at about the rate of a walk, or about four miles an hour.

The motive power will be carried by a cable or by electricity. Present conditions favor electricity.

It is claimed that with two seats abreast, such a series of platforms will carry 21,120 passengers per hour on the second platform, at six miles per hour, 31,680 on the third at nine miles per hour, and so on up to 63,360 passengers per hour on the sixth, moving eighteen miles per hour. Seating four abreast this figure just doubles.

RAILWAY ROLLING STOCK.

The railway car of 1831, of which some few specimens are yet in service or within reach of the eyes of the curious, excite a smile on the part of the railway traveler of to-day, from their small size, light weight, and meager accommodations. The rolling palaces of 1892 are noted for their size, their strength, their comfort and convenience, and the many appliances tending to make them safer in case of accidents. Improvements in this line have been many and various, and the sum total argues well for the satisfaction with which the traveler of the last decade of the nineteenth century will pursue his way almost unconscious of the motion which bears him to the uttermost parts of the earth as though upon the wings of a bird.

In a new vestibule for railway trains the doors slide into the car, leaving the platform unobstructed. This is done by making a recess in the closet partition or in a special partition inclosing a seat. The door is hung on rollers, and when it is desired to close the vestibule, is run out against a stanchion on the buffer beam and held by a spring.

On one of the English railways there has been introduced a device to render it possible for any passenger to partly apply the automatic vacuum brake. The effect of this is also to throw out a disk by which trainmen can know on which car the brake is applied. The engineer is supposed to know what has been done and to stop the train; but by the use of the large ejector he can exhaust sufficient air to release the brake and postpone the stop, if any emergency should seem to demand such action.

Ventilated freight cars for fruit have been tried with great success during the past summer, the buyers and their freight arriving in better condition than those shipped over the same route at the same time in the ordinary car, and in many cases bringing an extra price sufficient to pay for the freight.

A system of storing heat for street railways consists of an earthern tube inclosed in an iron pipe to which steam is supplied, sufficient heat being stored to keep the car comfortable for several hours.

The cushion car wheel is so called because there is a rubber cushion between the tire and the wheel center. The centers are either spokes or plates, of cast iron or steel. The tires are fastened by through bolts which are counterbored in the flange on the outside of the tire, the nut being recessed into the rim on the inside. There is a flange on the inside of the rim against which the tire bears. A steel band $\frac{1}{32}$ inch thick is put on outside the rubber; the tire is then forced on over the steel band and bolted or riveted in place.

In a new system of car ventilation the fresh air is admitted through a double screen at each end of the car, at the sides, then driven in by the motion of the car and thence down to the steam pipes which are inclosed, openings in the registers being in the sides of the inclosure. It is suggested that the pipes be filled with ice water in summer. In the clearstory are self-reversing exhaust ventilators on the outside of the car, on the inside are registers to regulate the temperature in cold weather.

A surface cattle guard has been improved so that it will not be materially damaged by loose brake beams, etc. There are strips of metal bearing saw-teeth upon their upper edges and lying parallel with the rails, set a few inches apart; at the sides there are inclined fences which may be of barbed wire or of plain slats, the barbed wire being intended to prevent the intrusion of the razor-back hog of the South. The guard when laid is suspended for the nine feet of its length and does not rest on the intermediate ties. Of course it does away with the risk of wrecking rear cars when the truck falls off a car into the ordinary deep guard.

A new railway car has no end platform, but has near the center of the car a vestibule or platform which is open only on one side and connects with the two compartments by doorways.

A new electric street car, weighing 28,000 pounds, is the joint invention of E. C. Sessions and C. L. Pullman. It is a " double-decker " concern, operated

by the trolley electric system. In general appearance it resembles the double-decked vehicles in common use in London and Paris. It is 32 feet long, seven feet four inches wide, and 14 feet 9½ inches high. The car seats forty passengers on each deck. The car body is so arranged that passengers may enter at the center of either side, where spiral stairs lead to the upper deck. Four stairways, combined into two at the bottom, separate toward the top, leading to either end of the car. The entrances at the center occupy no more space than the end platforms on ordinary street cars. The car is equipped with an electric chandelier and a double oil lamp in each compartment. Electric heaters are also set in the car. Two Westinghouse motors of 25 horse power furnish the power. The car rests on two trucks of special design, arranged with double-brake attachments and a friction brake. The efficiency of the brakes was demonstrated by the stoppage of the car within its own length while traveling twelve miles an hour.

The car requires the service of three employees, and cost $3,500.

An automatic brake-shoe wear adjuster is for taking up the slack of brake gear on railway cars as fast as it takes place through the wear on brake shoes. It is applicable to any brake gear now in use.

A car journal oiler, which has been tried on the Norfolk and Western Railway, consists of three pieces of felt, held together by a brass band, with a small sheet clip to prevent the felt from falling down. The pieces of felt are pressed against the journal by

springs at the end; and the whole device may be inserted in the standard oil-box without alteration of the latter. By this, only pure lubricating substance can reach the journal. The pressure of the journal on the center wick which wipes it keeps the side wicks, which are the lowest, from becoming gummed.

A pressed steel hand-car wheel is now being introduced. Its weight is but 35 pounds as against 55 to 90 for the ordinary cast iron wheels. It is composed of a single plate, pressed over to form the tread and flange and turned in at the latter; the hub being of drop steel riveted to the plate. After pressing, the material between the corrugations of the plate is cut away to decrease the weight, and the wheel then has the appearance of a spoke wheel.

A pressed steel truck particularly intended for freight cars is without equalizers, but has the springs over the axle boxes. The side frames are of steel plate $\frac{5}{16}$ inch thick, pressed into a large strong gusset which keeps the truck square, and gives it lateral stiffness. The transoms are of pressed steel.

A new car seal for freight car fastenings has a numbering device by which there may be kept an account, in connection with the ordinary seal required, of the number of times that the car has been opened. A lock on the same principle is used by the Post Office Department in sealing registered letter packages.

A weed-cutting car has been introduced in the West. It consists of a heavy hand car, on the side of

which opposite the brake is a six-foot horizontal cutter-bar the sickle of which is driven from the axle, and which can be folded up when passing bridges or other obstructions. It will cut as low as the ties will permit, and to a point eight feet from the rails. It can work on the angle of a hill or on the side of a cutting. The car can be run so as to cut weeds at four to five miles per hour, by four to six men using the ordinary pumping brake.

In a new design for air brake hose, the movable hose pieces are formed by circular overlapping disks of thin flexible metal, soldered on the outer and inner circumference, and by intersecting conical disks every one of which has flanges alternating.

In a new train pipe valve the steam supply for each car is controlled by one movement from the interior of each car, thus doing away with the necessity of cocks under the platforms and simplifying the friction of any system of equipment for steam heating from the locomotive.

A new commingler for heating the hot water in railway cars by steam from the locomotive consists of a chamber filled with pebbles, in the center of which the steam is admitted through a rose or other fine perforations, and are in connection with the train pipes. The heating apparatus is controlled by only one valve ; no thermostatic apparatus being used. Thirteen minutes is all the time required to get up complete circulation. With this system the drain cock can be opened and all pipes emptied before the car

is laid up, the car then standing cold without any danger of freezing. The pipes fill up by water of condensation from the steam.

Sweden is beginning to like the American system of swiveling trucks on railway cars ; but the Swedes use more iron in their manufacture than is the custom in America.

American cars have been introduced on the South-eastern Railway route to Dover, England ; on nearly all of the leading English lines the best trains have Pullman sleeping or drawing-room cars, and in some cases dining room cars.

Hydraulic buffers for railway use were the subject of an interesting paper before the *Verein Deutscher Maschinen Ingenieure.*

PROPOSED RAILWAYS.

WHILE the number of proposed railways is much less than has often been the case at the opening of a new year, and while perhaps also the number of miles proposed and building is less also, the year 1892 is already noted for the magnitude and boldness of the railway projects with which it opens. No longer satisfied with joining neighboring or even distant cities, in the same or in adjacent states, the railway projector turns his attention to making a steel bond between the metropolises of countries at the opposite extremities of whole continents ; and no longer content with opening out fertile lands to settle-

ment, he is plunging into desert and wilderness in the expectation and hope of bringing to civilized markets the products of savage lands.

THE TRANS-SIBERIAN RAILROAD.

The Russian Government is pushing forward with all possible speed the work on the Siberian railroad. The road will be twice as long as any of the American transcontinental lines. The Government has ceased to carry on other public works and railways. These enterprises must for some time be conducted by private companies without state aid.

The Government has resolved to open the road to traffic in 1895. Many engineers, however, are doubtful that this can be done, and some say that ten or twelve years will elapse before the road is in operation. It is probable, also, that the total failure of the crops in large districts of Russia, and the necessity for Government aid, may interfere with the progress of the railroad enterprise.

The estimated length is 4810 miles; with the spurs, over 5000.

The whole of the route has been mapped out, but only one-half properly surveyed. The other half has been partially examined, and a fresh party of engineers was sent from St. Petersburg to carry on the work. The surveyed portions are not continuous, but embrace long stretches of the road on different parts of the route. About 2500 miles of the road have been fully surveyed. The longest completed stretch of the surveys is on the central portion of the route, where, across the vast plains of Siberia, few engineering difficulties are encountered. About 1200 miles of this part of the route have been surveyed, and nearly

700 miles of the route directly east of Lake Baikal have been completely laid out. About 200 miles, also, of the extreme eastern end of the route have been surveyed. The extreme western end, between the eastern slopes of the Ural Mountains and the Obi River, is still unsurveyed, and the total length of the line which has not yet been staked out is about 2400 miles. The cost is estimated at $175,000,000.

The Government intends to transform the Port of Vladivostock, which is the eastern terminus of the line, into a first-class fortress, and to provide it with a harbor for the use of the Russian Pacific fleet. It intends to make it a second Sebastopol. From this port fast cruisers will issue to harass the ships and commerce of any nation with which Russia may be at war. The fortifications are now rapidly building, and, when completed, the port will be practically impregnable. The Government has supplied the authorities of the town with ice breakers, and so the port will be open all the year around.

THE TRANSANDINE RAILWAY.

This presents many difficulties which principally relate to tunneling and to overcoming great differences of level. The new railway joins two existing railways, and has a length of 149 miles, of which 109 are on Argentine ground. The terminal points, Mendorp and Santa Rosa, are respectively 2376 and 2704 feet above sea level, but between them the line rises to 10,460. The tunnels are at the highest points and take up 15 kilometers (9.32 miles). One of them is a spiral, 2061 yards long. The summit tunnel is 5665 meters or 5540 yards long. The spiral tunnel is at Portillo, and has a radius of 200 meters, equal to

about 10 chains. Eight of the tunnels are in sidelong ground permitting openings being made. The maximum grade is eight per cent. and extends for 15 kilometers (9.32 miles). The tunnels are for single line only. The air for the drills in tunneling has been conveyed by electric cables.

THE CENTRAL AFRICAN RAILWAY.

The proposed Central African Railway is to have its western terminus at Lagos, on the Slave Coast, and its eastern at Berbereh near the entrance to the Red Sea. Its length is estimated at 3000 miles and its cost at £15,500,000. This is to run through the southern part of the Egyptian Soudan.

The through route from London to Bombay *via* the Central African Railway would be from London by sea to Lagos, 5000 miles, 16 days; by rail to Berbereh, 3000 miles, 5 days; by sea to Bombay, 1700 miles, 6 days; total distance 9700 miles, time 27 days. The distance *via* the Mediterranean and the Suez Canal is 6500 miles; the time, 23 days.

The French contemplate a railway from Algiers across the Sahara to the neighborhood of Lake Tchad, 1900 miles; the cost being estimated at £6,650,000, and the cost of working £170 per year per mile.

The Germans have commenced the construction of a railway to run from Tanza Bay into the interior as far as Kilimandjaro, 223 miles; to cost £500,000; and the yearly working expense £242 per mile.

INTERCONTINENTAL ROAD IN SOUTH AMERICA.

The proposed intercontinental railway in South America should probably start south on the eastern side of the Isthmus of Panama, somewhere south of Aspinwall, going west of the Gulf of Darien into the Valley of the Atrato, up this valley to its head across the divide of the Cauca Valley and up this. From this valley to that of the Aqua Rico or Napo should be the most expensive to locate and build. Bogota can be reached by a line up the Valley of the Magdalena and *via* Honda; to Quito by a line up the Coca, a branch of the Napo. Lima will be more difficult to reach.

Erastus Wiman has a project for covering Staten Island with a network of electric railways, so that one can go from the edge into the middle of the island as easily as now he can get around it.

NEW YORK'S RAPID TRANSIT RAILWAY.

The Rapid Transit System proposed by the commission for New York City is the idea of the commission's chief engineer, W. E. Worthen. It provides for four underground tracks and a level road. The motive power is to be electricity or anything better that may be invented or devised before work on the road actually begins. The two outside tracks will be for local trains, and the inside tracks for express trains that shall be run at a speed of forty miles an hour.

There will be two main lines, one on the East and one on the West side, extending from the Battery to

the corporate limits. The plan also provides for a connecting cross-town line about Fourteenth Street. There will be in all thirty miles of road.

The proposed tunnel is to be thoroughly ventilated by artificial means and lighted by electricity. Fans placed at regular intervals between stations and ventilating shafts will be kept constantly in motion by electric power, and they will maintain a strong current of air. The commissioners believe that the tunnel can be kept free of dust and smoke and foul air, and that a moderate temperature can be maintained at all seasons.

As an extra safeguard against accidents the block system will be used. Enough lights are to be placed in the tunnels to keep the tracks so well lighted that it will be possible to see from one station to another.

The commission will recommend electricity as the best motive power for tunnels now in use, but the plans will admit of the adoption of any motive power that may be deemed to be better.

Coal-burning engines will be out of the question on account of the smoke. It is believed that a speed of forty miles an hour for the express trains can be maintained with electric power, and that is the highest speed contemplated by the plans and report of the commission.

The average width of the tunnel will be 44 feet and the height 11 feet 6 inches.

The roof of the tunnel will be nine feet below the surface of the streets, and the pipes, sewers, and subways will not be disturbed by the work of construction. In building the tunnels, the commissioners say it will not be necessary to disturb the surface of

the street, except where stations and air shafts are located.

The entrances to the stations will generally be located on private property, so that street traffic will not be interrupted.

The tunnel will be wider than some of the streets under which it will be constructed. In such cases the foundation walls of the buildings on both sides will be strengthened and made the side walls of the tunnel.

The roof of the tunnel will be supported by iron columns placed on concrete and stone foundations. The tunnel will be made watertight.

It will be necessary to increase the width of the tunnel at the double stations where both local and express trains will stop. At these stations the outer or local tracks will diverge to the right and left and the stations will be placed between the local and express train tracks. The express trains cannot be reached from the local stations.

The commission will furnish estimates of the cost of construction of the entire system. The commissioners declare that the cost will be so low that private capital will be invested in the enterprise.

Below the City Hall the tunnel will be only thirty-four feet wide, and will contain but three tracks.

There will be four tracks under Broadway to Fourteenth Street. There the two lines diverge, the East side going up Fourth and Madison Avenues, and the West side up Broadway and the Boulevard.

The Harlem River will be crossed by drawbridges fifty-seven feet high.

Above the Harlem River the roads will be partly underground and partly a viaduct.

The plan meets with very general dissatisfaction and opposition, and there is proposed instead, by engineers and others not of the commission, a four-track elevated railway which through the greater part of its length shall follow the course of the New York Central tunnel and tracks, above which it will be constructed.

THE MATTERHORN RAILWAY.

A very bold engineering project is to climb the peak of the Matterhorn by an extension of the Visp Zermatt railway 2½ miles up the valley to Gorge, and from this to make two high mountain railroads, one to Gornengrat and the other to the peak of the Matterhorn. The first branch is to be in two sections, an electric cable road and an electric rack road ; the first 4260 feet long with a rise of 2100 ; the second 13,940 feet long, 2660 feet rise. The gauges of both sections will be 2.52 feet. The superstructure will be the Abt rack and the motive power an electric locomotive of special and novel design. The Matterhorn branch is to be in three sections, an electric cable road, an electric rack road, and an electric wire rope road. There is to be an Abt rack 2950 feet long with a 1.28 per cent. grade connecting the adhesion road with the Matterhorn road proper ; the first section proper to be an electric cable 3740 feet horizontal, 1760 feet rise ; the second an electric rack 14,900 feet horizontal, 2700 feet rise ; the third 5830 feet horizontal, 4400 feet rise, with an average grade of 75.5 feet. The gauge of all these is to be 2.62 feet.

In the latter section the construction is more like a shaft than a tunnel. The road will emerge to the light of day about 60 feet below the almost vertical peak of the Matterhorn.

The proposed Three Americas railway, from New York to Buenos Ayres, is to be 9000 miles long. Of this distance more than half is already covered by railways, and 2000 miles more are being surveyed and constructed; leaving about 2300 miles to be provided for. The cost is estimated at $300,000,000.

Siam is to have a railway across the Malay Peninsula, from Singore to Saibwere, then to the tin district of Kulen.

There is to be a 265 kilometer railway between Bankok and Korat, Siam.

An automatic railway is proposed for Dundee harbor, to carry bales from the vessels to the sheds at the rate of 1200 per hour, by an ordinary tramway of 14-inch gauge, having an endless wire rope to haul the cars.

A railway is proposed from Vancouver to Alaska, following a route explored by the Western Union Telegraph Company when it sought to connect America and Asia before laying the telegraph cable. The route passes through a fertile valley containing 12,000 square miles capable of producing grain, while the mountains are rich in gold and silver.

The British East Africa Company has determined

to survey the district between the east coast of Africa and Victoria Nyanza.

A rack railway seven miles long is under construction on the Usni Mountain, Japan, to connect the termini of the state railway at Yokohama and Karnisawa. There are along the line twenty-one tunnels, 12,200 feet in length in all, and the steepest grade is one to fifteen.

A railway is to be built to supplement the Suez Canal by carrying the stores of the Canal Company itself, thus displacing the boats and bridges at present employed in that service; this being particularly needed now while the canal is being widened some 26 feet.

A portable railway has been designed for Africa to transport to Lake Victoria the steamer of the German agent, Wissmann. Man power will be used to propel it, about 1000 men being used. It will take five to six months to carry the steamer from the coast to the lake. The track length is 820 feet, the length of the train being 328 feet. The track sections consist each of two rails having a cross tie at one end. At the other end each rail has a hook by which it is fastened to the section just laid. Each section weighs 62 pounds.

FAST RAILWAY RUNS.

In 1891 there have been many records broken, at sea and on land, not only for short distances but for

long transits. In this particular the iron horse has covered himself with glory no less than has the swift steam bird of the ocean. The mere record of the successful and now wonderful performances of 1891 may seem to the critic of 1901 to be very mediocre; but to us they represent progress, and deserve at our hands the most intelligent and grateful appreciation.

The distance between San Francisco and New York has been covered in four days 12 hours and 38 minutes, over the Southern Pacific, Union Pacific and Michigan Southern, Lake Shore and New York Central railways. The number of miles run was 3307 and the average speed 30¼ miles per hour; weight of train and number of stops not stated.

The Michigan Central Railway ran a train from Chicago to Buffalo, November 1st, in 12 hours 23 minutes, making the average run for 536.5 miles 42.8 miles per hour, including all stops, and a ferriage at Detroit of 29 minutes. The regular time for the same trip is 14 hours 10 to 40 minutes.

A train of three cars on the Chicago and Northwestern road ran, in May, from Council Bluffs to Chicago in nine hours, exclusive of stops, or 53.92 miles per hour.

On the occasion of the opening of a new hotel in Washington the Pennsylvania Railroad ran a train from Jersey City to Washington, 227 miles, in four hours 11 minutes, including five minutes lost in changing engines at Gray's Ferry, and six minutes stoppage

for repairs to a brake. The cars weighed 125 tons; the locomotive and tender 76½. This rate is 54.4 miles per hour.

A remarkably fast run was made from St. Joseph, Mo., to Council Bluffs, Ia., over the Kansas City, St. Joseph and Council Bluffs, Ia., Railroad. A special was made up to test the practicability of running a new train to connect from the South with the Union Pacific overland flyer at Council Bluffs; and the train made 111 miles in 118 minutes, being 56.4 miles per hour, with three stops. This will afford material for reflection to the European railroad men who say that American trains can make fast runs only on the "good tracks" near the Eastern seaboard, but that on the Western roads forty miles an hour is exceptional traveling.

September 14, there was a run made from New York to East Buffalo, 436½ miles, in 439¾ minutes, including 7½ minutes delay for a hot bearing. The run was as follows:

Miles.			*Time.*	*Speed.*	
	New York		7.30 A. M.		
143	Albany	arr.	9.50 A. M.	61¼	59.52 miles per hour.
		dep.	9.53½ A. M.		
291¼	Syracuse	arr.	12.19½ P. M.	61	
		dep.	12.22 P. M.		
466½	East Buffalo		3.50 P. M.	58½	

The train consisted of an engine weighing 60 tons and a 40-ton tender, a drawing-room car 40 tons, a buffet car 33 tons, and a private car 38 tons, or 210 tons in all. The engines had cylinders 19"x 24";

the first having 6½-foot coupled drivers and the other 5¾. The first engine had 1821.5 square feet of heating surface and 273 square feet of grate. All the tenders took up water during transit, and carried 6¾ tons of coal.

On the Canadian Pacific a train ran from Vancouver to Montreal in 92½ hours, including three hours detention from a landslide. From Smith's Falls to Montreal, 128.3 miles, the running time was two hours five minutes, or 61.6 miles per hour.

December 2, a fast run was made with a heavy train on the P. C. C. & St. L. Railway. The train weighed 893,500 pounds, and the maximum speed was 70 miles per hour, while the average speed between Xenia and Columbus, deducting time for stops, was 50 miles an hour, and the average speed including stops 43 miles per hour. The leading engine of the two which hauled the train weighed 70,500 pounds and its tender 50,500; the second engine weighed 96,000 pounds and its tender 50,500.

A special train on the Philadelphia and Reading Railway was run August 27, making 12 miles in eight minutes 4½ seconds, or 82.7 miles per hour. The miles from the sixth to the tenth inclusive were run at 87 miles per hour. The fastest mile was made on a level just following a descending grade of 37 feet per mile. The engine weighed 98,000 pounds, tender 68,300; three cars making up the weight of the train to 337,250 pounds. The engine was number 206, class D 33, with a

Wootten fire box, burning hard coal; cylinders 18½ by 22 inches ; four 68-inch driving wheels.

A French fast train, built in the shops of the Northern Railway, with 16 carriages, weighing in all 667,800 pounds, ran from Paris to Calais, 184.56 miles, in three hours and 53 minutes, making two stops, one of five and the other of two minutes. The average speed, making no allowance for stops, was 47.53 miles per hour. From Paris to Amiens the speed was 51.58 miles, going up the Survilliers grade of 0.5 per cent., 11.17 miles long, at the rate of 46.6 miles. Going down the same grade the speed was 71.46 miles per hour.

Webb's new compound locomotive, the "Greater Britain," has brought up 25 of the London and Northwestern heavy six-wheel coaches from Rugby to Euston in one hour and 51 minutes.

TRAIN SPEED MEASURER.

Mr. Sabouret, engineer to the Compagnie des Chemins de Fer d'Orléans, has devised an apparatus for measuring train speed, consisting of a tuning fork having a point which inscribes a curve on the smoked surface of a cylinder turned by suitable mechanism. This is fixed at any part of the line, and as the train passes it sets the instrument in motion, stopping it when it has passed a given distance. The error is less than two per cent., even at a speed of 60 miles per hour.

HEAVY TRAIN HAULAGE.

A train weighing 3019 tons, exclusive of the engine

and cab, was hauled 30 miles on the Philadelphia and Reading Railway in 11 hours. The engine had 22 by 28-inch cylinders, and eight 50-inch driving wheels. The weight on the drivers was 138,340 pounds. The paying weight was more than two-thirds of the total weight hauled.

The Pennsylvania Railroad broke the record for fast travel between New York and Washington, by taking a special train from Jersey City to Washington, 227 miles, in four hours 11 minutes. The train had three Pullman cars weighing 285,420 pounds, and with the engine weighed about 242 tons. From Jersey City to Bristol, 66 miles, the time was 62½ minutes, the 26 miles between East Brunswick and Trenton being made in 23 minutes. It is said that the giving out of a brake at Baltimore delayed the train six minutes.

MISCELLANEOUS RAILWAY ITEMS.

THE railway of to-day is far reaching, many-handed and many-headed, and there are connected with its management and operation thousands of items that cannot well receive proper classification in a *résumé* such as this. In addition to the many interesting paragraphs which are presented under the heads of Locomotives, Permanent Way, Rolling Stock, Proposed Railways, etc., there are some no less interesting when taken in connection with others there classified, or even alone; and these are here recorded for the reader interested in railway matters in general.

A new device for raising water to railway tanks

consists of a bucket with a capacity of 2000 gallons, which is raised from the well or reservoir by the locomotive, and which automatically empties itself into the water tank ; the idea being to hook on to any part of the moving train with a wire rope running through suitably-arranged sheaves. As the engine moves away the bucket is raised to the desired elevation. When the bucket is emptied, the rope is cast loose from the train and the bucket allowed to descend, at a rate controlled by a governor.

A flexible steam joint to be used on steam-heated trains between locomotive and tender is without packing. On the end of a pipe connected to a valve leading from the boiler is a hollow cast iron sphere, ground true on the outside to make a tight joint in a screwed ring which is ground true on the inside. The lower half of the joint is also of cast iron and is turned out to receive the hollow sphere, but is not intended to make a joint therein. When the ring is screwed down, the sphere is so loose in the cavity that water of condensation in the pipe can run out; but as soon as the pressure is brought on, the sphere is forced to its seat and a tight joint made. This self-draining feature specially adapts such a joint for use with rock drills, and in saw mills in cold weather.

A new German coupler between locomotive and tender is hinged on the outside in two horizontal trunnions and on the locomotive on one horizontal trunnion. On the outside the coupling rests in two bearings which are screwed upon the chafing-plate under the platform ; on the engine it rests in a sliding

piece which is attached above and below to the foot plate and turns freely on the coupler bolt. The new coupler makes it possible to shorten the engine frame and to replace the cast iron coupling by wrought iron, thus lessening the weight.

THE TRAIN STAFF SYSTEM.

The "train staff" system of running single-track roads is used on the Shore Line Division of the N. Y., N. H. & H. R. R. At each end of the single-track section, in the switchman's house, there is a box containing tickets, red for one end of the section and white for the other. The box has a lock which can be opened only by a key in the end of a staff, upon which is a plate bearing the words "Niantic and New London." The key may be slid out for use or drawn in for protection. There is only one staff for the section. The engineer of the train approaching the section (if not followed by any other train), upon entering the red ticket end of the section, takes from the switchman the train staff, and retains it until he reaches the end of the section, when he delivers it up to the switchman at the opposite or white ticket end. So long as the staff is retained by the switchman, no train can follow the outgoing train, as the switchman who gives up the train staff has no way of opening the box, and cannot authorize a train to follow the first one, either by giving the engineer a ticket or by handing him the staff. If other trains are to follow the first one entering the single-track section from the same direction, the switchman gives the engineer of the first train a red train staff ticket from the box in the switchhouse; at the same time he shows the

engineer the train staff, thus indicating his authority to dispatch the train and to send the second train upon its arrival. If but two trains are to pass over the section in the same direction, the switchman gives the engineer of the second train the train staff, and it is carried to the opposite end of the section and there delivered to the switchman, as in the first case. A red ticket will allow a train to pass in only one direction, a white one being needed for the opposite direction. Two trains moving in opposite directions cannot occupy the same section at the same time where this system is rigidly carried out; and the engineers and the switchmen are directly responsible for the safe passage of the trains. This system has been used in Europe on short lines, bridges, etc., and has been extensively adopted in Australia.

Messrs. Martin & Theodor Perls, of 62 Basinghall St., London, have brought out a system of railway signalling by which, if two engines come on the same section of line, bells are automatically set ringing in each one by an electric current. This is accomplished by lengths of conductor alongside of each rail, each separate length being entirely disconnected from the preceding and the following one on the same side, although each length on the left side is connected to the one just in advance of it on the right side. The lengths on the two sides break joint. Centrally between the rails is an additional conductor, which is continuous. Each engine has a battery and an electric bell. Two engines on the line at the same time make electric connection with each other's bells.

In a recent idea for a pneumatic signal there is a

disk 12 inches in diameter made of two pieces of plate glass, one-eighth inch apart, in a copper band. In the bottom of this band is an opening to which is soldered a pipe connecting with a reservoir above the signal. At the top of the band there protrudes, from between the glass plates, a pipe to which is affixed an air tube which runs to the office from which the signal is to be operated. A red liquid is poured in the reservoir and flows down through the pipe and up between the glass plates, filling the space between them and making the disk in its normal condition red. This may be changed to white by forcing air between the plates. It is said to work well 100 feet from the operator, with but slight effort on his part.

In an electro-mechanical controller for operating a signal from an adjacent tower by the usual lever and connections, and also from one too far off for mechanical connections, there is the well-known balance lever weighted so as to put the signal to danger in case of rupture of the connections. This lever is centered on a link which is fastened to a horizontal diaphragm held in position by atmospheric pressure under it ; but by opening the electric circuit an electro-magnet releases a spring, raises a valve stem about one-sixteenth inch, letting air into the diaphragm chamber and allowing the diaphragm to drop and set the signal to danger.

A new train order system works entirely by electricity ; its hands can be placed where it is most convenient, and not necessarily in front of the office ; and it has provision against letting a train pass while there are orders for it, through the operator's forget-

fulness. It permits the train to be held beyond the station, so that a train can be held for orders, and at the same time permits it to stop where passengers or freight can be discharged and water taken on.

The mid-European or fifteenth meridian time has been adopted on most of the railways in Germany and Austria.

The zone system of railway management is to be introduced on the Cork, Black Rock and Passage Railway Company, the result being that instead of one hundred and fifty different sorts of tickets being issued at Cork there will be only eight; while the new scale of fares will be lower all around by 30 per cent.

The Pennsylvania Railroad has completed at Jersey City a new passenger depot, having a truss roof with a clear area of 256 by 600 feet, carried by 22 iron trusses, arranged in pairs, 14½ feet between members of pairs, and 43½ feet between pairs. The height of trusses is 90 feet from the ground level; and there is a clearstory 26 feet high. The trusses were built upon scaffolding 234 feet wide, 60 feet deep and 84 feet high, being deep enough to include three trusses. The great train-room of the Grand Central Depot in New York is only 652 feet long and 199½ feet wide.

The entire Jersey City train shed is 653½ feet long, 256 wide, 112 high, and weighs 4,550,000 pounds.

CANALS.

It may be set down as a fact that the cutting of great ways, joining vast bodies of navigable water,

and shortening by from days to months the water transit from one great port to another, is one of the infallible measures of progressive spirit in a people.

At present there are several under way, including the American project of connecting the Atlantic and Pacific Oceans across the Isthmus of Darien; and some of these find here a chronicle, more or less brief.

THE NORTH GERMAN CANAL.

The cutting of the ship canal through the province of Schleswig-Holstein to connect the North Sea with the Baltic is progressing rapidly, and it is believed that it can be completed by April, 1893, or a little more than six years from the day on which the first spadeful of soil was turned in the presence of Emperor William I. at Holtenau, near Kiel. Since the sixteenth century sixteen plans have been urged for connecting the two seas, and the last two form the basis of the project now under way.

It starts at Holtenau on the north side of Kiel Bay, and joins the Elbe near Brunsbüttel 15 miles above its mouth. From Kiel Bay to Rendsburg it follows the Schleswig and Holstein canal, which was made 100 years ago; then follows the Eider to Willenbergen. It is 61 miles long, 200 feet wide at the surface and 85 feet at the bottom; the depth being 28 feet. No locks are required; but there are flood gates at the Eider Junction and at its termination.

As the mean water-level of the North Sea is considerably higher than that of the Baltic, both openings are to have huge locks. Near Rendsburg is to be another lock to connect the new canal with the old Eider canal. The medium water-level is to be about

equal to that of Kiel harbor, and the locks at the outlet on the Baltic are to be open nearly always, or except during the periods of considerable variation in the water-levels. At the lowest tide the navigable width is to be about 119 feet, so as to allow the largest Baltic steamships to pass each other. The movements of war vessels and the largest vessels of the merchant marine were considered in making the curves, because they cannot pass a curve with a short radius. Between two counter curves a straight line has been drawn for safe navigation. A speed of 5.3 knots is admissible. About 63 per cent. of the canal has straight lines.

From Holtenau to Rendsburg the line runs through a very undulating country, and there it has the greatest number of curves. In front of the outlet into the River Elbe is to be a roadstead. In cutting through about nine miles of the watershed of the rivers Elbe and Eider an excavation of about 98 feet to the bottom of the canal is required. Between Rendsburg and the Baltic a ridge must be cut through, and just beyond Rendsburg the upper Eider lakes must be lowered for the canal to pass through. The flow of the canal is toward the Elbe, but at high tide in the Elbe it will discharge into the Baltic Sea. The banks are to have stone packing to diminish the force of waves.

About 7000 workmen are employed in the construction. They are in 38 camps, of 160 to 500 men each, each camp having its own executive office and sleeping barracks. The common laborers get about seventy cents a day, and the foremen and skilled laborers get from ninety-five cents to $1.15 a day. The mechani-

cal appliances are 27 dry dredgers, 24 floating dredgers, 97 locomotives, about 62 miles of track, 2700 dirt carts, four elevators, 15 steamboats, 51 receptacles for dredging implements, and 37 steam pumps. Along the line are several forges and two brick yards. The total cost is fixed at about $37,128,000. About one-third of that amount was paid by the Russian Government before the work was begun. The rest is to be paid, as required, by the German empire. The construction is under the management of the Imperial Canal Commission.

The depth of water will be sufficient for the largest German vessels. The canal will be of great advantage to the timber and ice vessels trading between St. Petersburg, Stockholm, Dantzic, Riga, and all the North-German ports in the Baltic and England, as the passage by the Kattegat and Skager Rack is very dangerous. The distance sailed between Baltic ports and the Thames will be 250 miles ; to Lynn or Boston (England), 220, to Hull 200, to Newcastle or Leith 100.

The regulations for the working of the canal have been adapted to the traffic to be anticipated. The traffic between the Baltic and the North Sea, including vessels from a greater distance, embraced, on the average, from 1871 to 1880, through the Sound, 35,246 vessels ; through the Belts, 4000 vessels ; through the Eider Canal, 2258 vessels, or a total of 41,504 vessels. Of that traffic four-fifths, it is believed, may be counted on for the canal in the near future. About 27 steam vessels and 30 tows, of three to four sailing vessels moving in one direction, can go through in a day. The time saved by a steamship running be-

tween Kiel and Hamburg by way of the canal is estimated at 2½ days. The time of passage through the canal, including stoppages and delays, is to be about 13 hours. Germany's naval ports at Kiel, on the Baltic, and at Wilhelmshaven, on the North Sea, can be within easy access after the completion of the canal, whereas now a squadron is three days from port to port.

Four railroads cross the line of the canal, but three of them are to be conducted over it by turn bridges and one by a suspension bridge near Grünthal. For two of the much frequented country roads turn bridges are to be built, and for the other sixteen ferries are to be provided.

THE MANCHESTER SHIP CANAL.

This canal will use over 1,250,000 cubic yards of concrete in addition to 175,000 cubic yards of brick work, and 220,000 cubic yards of masonry. It has about 30 fluid sluices which have an edge almost as sharp as a knife, resting upon a planed steel sill. They are of the rolling type, are fully balanced, and are raised by gearing. They work so easily that the power exerted by a man raising them in free air, and with ten feet of differential head, was about the same, the head making on them a pressure of about 45 gross tons. The canal is to have an electric launch service established by one of the best known English companies.

The contractors for the Corinth ship canal have found trouble by reason of enough slope not having been given to the clay banks. As the cut is in many

places 250 feet deep, it will be seen that the change in the slope will very greatly increase the amount of material to be removed and the cost of the canal.

There will soon be a navigable depth of 20 feet from Duluth to Buffalo.

PROPOSED CANALS.

Another ship canal project is to join Lake Erie with the Ohio River from Conneaut to Rochester on the Ohio, so as to give a depth of 14 feet to Pittsburgh, for steamers of 1500 tons. This would cost $27,000,000. It is figured that such a canal would reduce the cost of carrying ore to Pittsburgh from Lake Superior by $2 per ton.

The project for connecting New York and Philadelphia by a ship canal across the State of New Jersey, utilizing if possible some of the natural water courses of the latter State, and which project was advocated in 1873 by the editor of this RECORD, is again occupying a slight measure of public attention; and it is to be hoped that, before the close of 1892, it will have gone at least so far as to have resulted in a suitable commission to make surveys and report to the legislatures of the three States most interested. Such a canal would in great part relieve Philadelphia of its present condition of being merely an inland city, and would greatly lessen the cost of freight on coal, iron, etc., to the seaboard.

An appropriation has been made for a survey for a

ship canal to connect Lakes Union and Washington, back of Seattle, Washington, five miles, including two miles through Lake Union. This is to give Seattle some of the advantages now possessed by Portland on the Columbia river.

Chicago is at present engaged in considering the solution of the problem of securing such a water way as shall dispose of the sewage for many years to come; shall relieve the dwellers on the line of the canal from all nuisances arising from the sewage disposal; and shall provide a navigable channel for deep-draft vessels. The most favored scheme, that of Mr. Cooley, embraces a canal commencing near the mouth of the Chicago River, passes through a cut in the low ridge forming the summit level, runs to Lake Joliet and through the valleys of the Desplaines and Illinois rivers to the Mississippi at Grafton (325 miles), where the low water level is 172.4 feet below the Chicago datum, and where the high water level is 20 feet above low water.

The project provides that the depth of the canal shall be not less than 14 feet as far as Lake Joliet, thence to La Salle 14 feet at first with provision for increasing to 22 feet. This would take 10,000 cubic feet per second from Lake Michigan and pour it into the Mississippi; this being about 4½ per cent. of the total amount that goes over Niagara.

A water way is proposed from Sheffield, England, to the sea, to be 5½ miles long and to extend from South Yorkshire, England, to the Aire and Calder navigation, the new channel joining the latter about

seven miles from Goole, so that by the river Oude the manufactures of Sheffield, Rotherham, and other industrial centers in South Yorkshire, will pass to the sea in addition to these of Leeds, Wakefield, etc.

A company of Russian capitalists has applied for a charter to dig a canal by which the river Amoo-Daria shall be joined with the Caspian Sea. The company desires to establish a steamship line on the new canal and along the Amoo-Daria.

Mr. E. L. Corthell read a paper before the Canadian Society of Civil Engineers on the practicability of making an enlarged water way from the Northwest to the Atlantic seaboard and Europe; the intention being to provide for vessels of 3000 tons of cargo and having 5000 net tons displacement, with 20 feet draft. The author places ship railways on an equality, as transportation methods, with canals; considering them in many respects superior, first, in that the cost of construction is generally about half that of the ship canal; second, the cost of operation and maintenance is less; third, the rate of speed is greater, and the detention *en route* is less by reason of the absence of locks.

The Ulefos-Strengen canal in Norway, instead of costing $275,000, will cost more than double that.

The Panama Canal is practically a thing of the past; the rains have caused land-slides to fill up the cuts.

Wiebe has found by tests, on 3½ miles of the Oder and Spree Canal, that the submerged chain system is

unsatisfactory, and the endless rope system impracticable, by reason of the rotation of the tow rope tending to twist the boat painter about it. Attaching the rope to the center of gravity of a heavy towing car, running behind and drawn by a light locomotive such as is commonly used in mines, gives good results; boats being towed at from 10 to 12 feet per second. The tension in starting three heavy coal barges was 1764 pounds, but rapidly decreased as the boats gathered way.

TUNNELS.

Each decade man becomes more and more aggressive and more impatient of any obstacle which lies between him and the accomplishment of his desires for easy transit, for abundance of water supply, or for the obtention of mineral treasures from the bowels of the earth. The invention and introduction of high explosives, and the increasing superiority of drilling machines for penetrating hard strata, as well as the facility now offered by the hydraulic shield, for progress in even the softest materials, have given an impetus to tunnel engineering which will doubtless prove as productive as it is surprising.

THE SIMPLON TUNNEL.

Another great railroad tunnel is to be dug through the Alps, and Geneva is greatly rejoiced because she thinks she will now get some of the travel which has long been attracted over the Gothard route to Zurich and the Reuss Valley. The tunneling of the Simplon

has taken definite form and work has begun. The tunnel will connect the Jura-Simplon Railway Company's line, which now terminates on the north at Brigue, with Domo d'Osolla on the south, in Italy, at the existing terminus of the Italian-Mediterranean Company's line. It is estimated that the total cost of the tunnel and approaches will be $15,000,000.

From Brigue to the center of the mountain there will be but a single boring, large enough to receive a double track. The tunnel will then be divided into two smaller ones, running parallel and each containing a single track. It is thought this plan will be most economical and better for ventilation. An exhaustion shaft is to be made at the highest part of the boring, where the tunnel divides and where the volume of smoke and gases will naturally be greatest. The junction of these two railway systems will bring southwest Germany into more direct communication with the important towns of northern Italy.

ANOTHER THAMES TUNNEL.

The London County Council has signed the contract for the Blackwall tunnel under the Thames. It will be 27 feet in outside diameter, commencing on the north side in the East India Dock Road, ending on the south side on Greenwich Marshes. On each side there will be an opening approach of 300 yards. The total length of the tunnel proper will be 4464 feet, of which 1212 will be under the river. The interior diameter will be 23 feet, which is 5½ feet more than that of the largest tunnel ever attempted of its class. There will be a roadway of 16 feet, for two lines of vehicles, and a footpath each side of three feet.

The headway will be 17 feet 1½ inches in the center. The space under the roadway will have a subway 4 feet wide by 4½ feet high, for drainage, lighting, etc. For 3693 feet the tunnel will be of iron with a lining of white glazed bricks ; 761 feet of "cut and cover" will be of concrete and brick, and 1645 feet of open cut of the same material. The iron will be 2 inches thick and the brick lining 15 inches. The bore will come within 6 feet of the river bed, and nothing will come between the shields and the 46 feet of water at high tide but 6 feet of gravel. Work will be begun at several points, three of the shafts for this purpose, 60 feet in diameter, being kept permanently as stairways for foot passengers and a fourth for ventilation. The contract has been let for £871,000 ; being about one-third the price per yard that was paid for the old Thames tunnel.

A tunnel 5 miles long is being driven through the solid rock under Crow's Peak, 60 miles west of Denver. It is 8 by 18 feet in cross section, and will later be enlarged for railway purposes. It is all through rock.

Mons. Pochet has devised a method of ventilating railway tunnels, by dividing the tunnel into two chambers by a horizontal partition 15 feet above the rails. In this there are two continuous lengthwise flues, converging toward the top and closed by upward opening balance valves. The upper smoke chamber receives the steam and gases of combustion from the under part, and the valves prevent their return. Pochet calculates that for forty trains the

ventilator will need to take care of 175,000 cubic feet of air and gas per mile; one-half of this being air carried along by the exhausts. The same system, or a modification thereof, has been proposed for the Central Railway Tunnel through New York City.

The railway connecting the Argentine Republic with Chili will call for eight tunnels through the Andes, with a total length of nearly 10 miles. These tunnels have been commenced at 26 points, and in their construction the natural water powers are being made to develop power, which is carried by electricity to where the borers need the power; where it is used in air compression for the drills.

The Jeddo tunnel is to be driven to drain the flooded mountains of Jeddo and Harleigh; to run from Butler Valley, Pa., to the bottom of Ebervade Mammoth Vein, three miles, through solid rock, and to be eight feet square in the clear. It is to be done by the Jeddo Tunnel Company, Limited, and will drain all the collieries in the valley.

The drainage tunnel for the Valley of Mexico, 9.76 miles long, is being driven through hardened volcanic mud, being the "tebebate" through which Martinez, in 1608, drove a drainage tunnel four miles long in eleven months, with crude appliances and Indian laborers.

The Metropolitan Railway of Paris is being laid under conditions which approximate those which exist in New York, but the methods there employed

are vastly different. Their method of procedure is to first trench down and lay the foundation wall and side wall of one side; then cover over and use that side, and do the same thing on the other side; then construct an arch upon natural earth between those two walls; then excavate under this arch, and last, restore the top roadway to its original condition. In this way only one-third of the road width is closed to traffic at once, and then only in short sections. The moving and re-construction of the sewers proceeds on the same system.

The Reno tunnel proposed for Broadway, New York, would be of cast iron in places where there would be excessive dampness. The walls, floors, and roofs would be composed of flanged panels of cast iron about two feet wide, set in place in the rear of a rectangular shield pushed forward hydraulically. The tunnel would have four compartments, two above and two below, each large enough for a single car track.

The St. Clair River tunnel was opened September 19, between Sarnia, Canada, and Port Huron, Mich. The architect, designer, and builder was Joseph Hobson. Use was made of two shields, each 21 feet seven inches in diameter and six feet long, of inch-thick plate steel; with the Haskins compressed air system. The walls of the tunnel are of segmentary iron plates bolted together; 13 plates and a key forming a ring of the tunnel. The lower half is lined with massive brickwork. There are in the roof two ventilating tubes, 20 inches in diameter, extending to the center of the tunnel and passing to the entrance,

where they connect with blowers. The tunnel is 6050 feet long from cutting to cutting; 1800 feet from the American cutting to the river edge, 2300 feet across the river, and 1950 feet from the river edge to the Canadian cutting. The cost will fall below the original estimate of $3,000,000. By the time of publication of this book this tunnel should be finished and opened.

A tunnel scheme is devised by the N. Y. & L. I. R. R., to extend under the East River from Long Island City to New York. The terminus of the New York side is to be at West Forty-second Street and Tenth Avenue; and that on the Long Island side at Thompson Avenue, near Dutch Kills.

The Canadian Government has in contemplation a railway tunnel under the Straits of Northumberland, connecting the shores of New Brunswick with those of Prince Edward's Island. The greatest depth of water is 96 feet at high water, with rises of tides of six feet at spring and three at neaps. The distance is 13,200 yards between shores, or 13,500 from shaft to shaft exclusive of approaches. The length of tunnel from shaft to shaft would be 7.67 miles. To accommodate Canadian and American rolling-stock it should have a diameter of 18 feet, and would cost about $700 per yard, or, with land tunnel, etc., $11,127,500.

It is decided to drive a tunnel instead of a bridge at Detroit.

At Cleveland, O., Powell has submitted a design

for constructing a steel tunnel for the waterworks intake, to extend two and a half miles into the lake. It is to be of half-inch plates in 1000-foot sections, and to be eight and a half feet in dimeter. The cost is put at half that of a brick tunnel ; the time of laying four months, and the duration 50 years.

There is a project to tunnel under the Niagara River from Buffalo to Fort Erie, Canada. A tunnel here would cheapen freight and passenger rates, and would be of service in uniting commercially two great countries between which Nature has set a barrier almost as effective as it is marvelous and awe-inspiring. This tunnel would not only provide additional traffic facilities, but lessen the risk of intercommunication being broken off by accident to comparatively frail bridge-structures.

The first proposed Irish Channel tunnel is stated by Sir Roper Lethbridge to be feasible, at a cost of £10,000,000. It would pass through its entire extent through a compact marl, red sandstone, and the rocks of the lower Silurian type. The shortest route is that proposed by Maccassey between the Mull of Cantire and the coast of Antrim, 14½ miles across the water ; but it requires ten miles additional railway. Mr. Barton's plan is for a tunnel 33 to 34 miles long, of which 24½ would be under water. The plan between Whitehead and Port Patrick, proposed by F. W. McCullough, is but 23½ miles long, with 3½ miles of land approaches.

There will be a 14,700 feet single track tunnel un-

der the Seine in Quillebœuf; the 8200 feet which pass under the river bed through the soft alluvium being lined with cast iron.

A tubular tunnel under the Sound, between Elsinore and Helsingborg, is proposed; of a length slightly over four miles, and raised on pillars consisting of iron boxes filled with concrete. The tunnel is to be below the liability of vessels of the deepest draft touching it. The pieces are to be over 100 feet long, consisting of an inner and an outer wall with the space between filled with concrete. As the entire weight of the tunnel will be about equal to that of the water displaced, the pillars will be only slightly loaded.

The Channel tubular railway proposed by Sir Edward Reed is to run in tubes of steel or iron and cemented concrete, laid on the bottom of the sea. In no place on the line selected does the depth of water exceed 200 feet; and for several miles out from the English coast it is not 100. The grades would be less than one in 160 as a maximum; being less than half that of the Severn tunnel. The tubes would be towed by steamers from the building ports on the Channel as required; and each length of tube laid is to be the means and the instrument of bringing the next length into position with accuracy. The plan is that one end of the pair of tubes—they being laid in parallel, each to accommodate an up and down line respectively—is to be kept afloat while the other end is attached to the continuous line at the bottom of the sea. Thus the end of the completed

portion is kept afloat, and the length, consisting of a pair of tubes, is towed out and the operation of joining up performed. The tubes are to be supported on piers which are to have knife edges so as to cut into the bottom. The tubes are to be connected together and to be 50 feet apart; being about 20 feet in diameter and in 300-foot lengths. There seems to be no provision for ventilation.

BRIDGES.

WHILE there is no great Brooklyn bridge now under way, and while the equally wonderful structure across the Firth of Forth is an accomplished fact, the bridge builder has by no means retired from active circulation. The North River is to be spanned, at New York, with structures which should prove of even greater service to the metropolis of America than the East River affair, which the writer begs to think has been and is very much over-rated as a work of engineering and as a means of communication between two great cities.

According to the plans now being carried out, the great steel bridge across the Columbia at Vancouver will be one of the most notable as well as gigantic constructions of its kind. It will be 6000 feet from the Washington to the Oregon shore, will be double-tracked, with roadway on top for teams, and the whole erected upon pneumatic piers. The pivotal pier, or draw pier, will support a draw giving an opening of 200 feet space on either side for vessels,

and the span which is immediately south of the draw will be 375 feet. The whole structure will be of steel, built ten feet above the high water of 1876, and 40 feet above low water. Among the engineering difficulties presented the most notable has been the sandy foundation, rendering it necessary to go down some eighty feet below low water to obtain a firm foundation. The estimated cost is $4,000,000.

St. Louis is to have a new bridge for a double track railway; consisting of three spans of steel superstructure upon masonry piers, each span giving a clear waterway of 500 feet; the lowest point of the trusses to be 52 feet above the city datum. The total length of the bridge will be 2420 feet.

Work has been begun on the new bridge over the Harlem at Seventh Avenue, from plans by Boller. There will be a draw span of 412 feet, giving a clear waterway of 160 feet either side of the center pier. This draw will weigh about 2400 tons, and be moved by a 60 horse power engine. The bridge will be 67 feet wide over all, with a 40-foot roadway. The length will be 731 feet, with 1740 feet of approaches; making a total of 2471 feet.

THE HUDSON RIVER SUSPENSION BRIDGE.

In the proposed Suspension Bridge between New York and Hoboken there are five divisions, a central span, two land spans, and two approaches. The bridge proper will start from Bloomfield and Twelfth Streets, Hoboken, and end at Twenty-third Street and Tenth Avenue, New York, the distance being 6650 feet.

The central span will be 3100 feet from center to center of piers; the shore spans are 750 feet each. The clear span of the central bay is to be 2920 feet. At the point selected there is a space of 2740 feet between pier head lines as stipulated by law. The structure is to be of steel for roadway and towers; stone and concrete for anchorages and foundations. Double steel towers, 525 feet high, on foundations 180 by 350 feet, will carry the four cables, which will pass over balancing saddles and be in pairs, 48 to 50 inches in diameter each, and 55 feet apart vertically. The cables will be of steel wire, laid parallel and bound together at intervals, but not bound with wire, but surrounded by a watertight sheet steel fastening, with two inches of air space all round. The center and the cables will rise and fall nine and a half feet, thus lifting the bridge a maximum of four and a half feet. With 1330 locomotives upon it from end to end, only one-third its strength will be called upon. The dead weight of the structure will be nearly three and a half times this amount. There are to be three decks, although only one will be made at first—the lower one, which is to carry six tracks at first, later eight. On the second deck there are to be four rapid transit tracks, and there will be room for heavy surface tracks. The third deck is to give a 20-foot wide promenade. The character of the approaches renders it impossible to provide for a wagon way.

ANOTHER NORTH RIVER BRIDGE.

Lindenthal's proposed North River Bridge is to have a length of 7340 feet without approaches; the link span

3100 feet ; to carry 14 railway tracks ; capacity, 20 freight trains, each 500 feet long and weighing 800 tons, on each link span, or 30 500-foot long passenger trains weighing 550 tons ; average weight of superstructure per foot of span, 45,000 pounds ; average weight of steel and iron in superstructure per foot of span, 42,000 pounds ; total cost of construction alone, $28,500,000, which represents $3880 per lineal foot of bridge. It would be absolutely safe if loaded to its full capacity with locomotives ; and it would take, to do this, 1800 locomotives, or 20 per cent. more than the number possessed by the Pennsylvania Railroad. The principal bridge members, the four cables, will be of steel wire of 175,000 pounds per square inch tensile strength, weighing only one-third as much as steel parts of large section. There will be needed but two deep submarine foundations.

BRIDGE AT LYONS.

Clavenao has a project for a bridge between Fourvierre and Croix Rousse, Lyons, France ; being an elliptical arch with a span of 214 meters and having three points of support for the viaduct, the estimated total length of which is 564 meters between the abutments ; the points of support being the key of the arch and two lattice-work towers supported symmetrically upon the haunches of the arch. The viaduct is to be formed of two great girders, 5.28 meters between axes, and 532 meters in height. The Eiffel establishment proposes for the same place a cantilever on mixed piers of masonry at the lower parts and metal above. The viaduct should carry a central span of 142 meters, two lateral spans of 85 each, two short

spans of 63, and approaches of 50 and 90 ; total, 578 meters. There are two large piers, two small ones, and two abutments. The large piers are 56 meters in height from the level of the landing-places to the point of support of the girders. Their section is 20 by 10 meters at the base and 16 at the top.

The Wolfe Island Bridge Company proposes to build a railway bridge across the St. Lawrence, from Cape Vincent to a point near Kingston, Ont.

The Canadian Pacific R. R. Co. has put up a 3300-foot wooden bridge at Milford, Manitoba. There was used in its construction 1,300,000 feet, board measure, of material, and the time taken up in its erection was five weeks.

The Verrugas Cantilever Bridge was opened for traffic about the first of the year. It is 575 feet long, 105 feet between the towers being suspended. At its middle point it is 252 feet above the valley which it spans. The chasm is 235 feet wide.

Chicago has a new type of folding bridge over the North Branch Canal at Weed Street. The river is 150 feet wide between dock lines, and the bridge leaves 62 feet clear opening. Each half consists of two girder sections supporting the floor, hinged together at their points of suspension and hung from the tower by tie-rods at the points of junction to the ends of the tower girder sections. The floors fold back and drop down, so that they assume a vertical position against the side of the tower, while one edge

is higher than the bridge floor, and thus presents an impassable barrier to teams while the draw is open. The varying mechanical power required to operate the bridge at various positions of the floor is produced by a series of cams which give the ropes a variable leverage, as in the fusee of a watch.

Many German engineers prefer masonry to iron for bridges, and they have revived the practice of building masonry bridges with lead joints at the key and points of rupture near the spring lines. The Romans used sheets of lead between cut stones, and in bridges built in England in 1833 bands of lead were placed in the joints, for two-thirds of the distance above the springing line. The use of lead is for maintaining the proper interval of joint and for uniformly distributing the pressure.

The United States law, that bridges over navigable streams must be built under sanction of the War Department, is to be enforced more vigorously than formerly.

ARCHITECTURE AND BUILDING.

It is to be hoped that the doom which befell the builders of the tower of Babel will not be the lot of those ambitious architects and builders who are vying with each other as to who shall plan or erect the tallest building on earth. In the constructive sense the competition is useful, in that it draws out the ability to design, erect, and maintain upright structures of

immense height, even upon the most shifty and unstable soil; but architecturally the competition is to be regretted, as beauty is sacrificed to size; variety gives place to repetition; and height seems to be the crowning prerequisite, entirely irrespective of fitness, beauty, first cost, or ultimate paying qualities.

BIGGER TOWERS THAN EIFFEL'S.

A commencement has been made toward the building, in London, of a tower higher than the Eiffel. Benjamin Becker and Mr. Alan D. Stewart are at work on the design. Sir Edward Watkin is at the head of the movement.

THE CHICAGO SKY-PIERCER.

Chicago is to have, during the World's Fair, a tower taller than Eiffel's. After long-continued negotiations, the Keystone Bridge Company of Pittsburgh made offers in writing, and the Keystone Company agreed to construct the metal portion of the tower and have it completed by February 1, 1893. The company expects that the tower will be built by October 12, 1892. In that case it will receive a bonus for the time saved. Options have been secured on grounds adjoining the World's Fair site and arrangements made with the World's Fair officials so that, if desired, the tower grounds may be included within their jurisdiction.

The designs have been made by Engineer George S. Morrison of Chicago. The actual cost will be about $1,500,000. The cost of the Eiffel tower was a little less than $1,700,000. The difference is in the greater simplicity of design of the American tower

and the use of standard and merchantable sizes of steel.

The tower will be 1120 feet high, and will accommodate more than 25,000 people at one time. Two of the many elevators will start from the ground and run up more than 1000 feet without change or stop, directly to the lookout landing. The diameter of the tower at the foundation level will be 440 feet.

The three landings will be circular platforms, the first 250 feet in diameter and 200 feet from the ground, the second 150 feet in diameter and 400 feet from the ground, and the third landing, or "lantern," 60 feet in diameter and 1000 feet up.

At the first landing there will be a grand colonnade around the outside, 15 feet wide and 738 feet mean circumference. On this four or five thousand people can be accommodated. Inside this will be space, in addition to that required for elevators and machinery, sufficient for four hotels or restaurants.

In addition to the restaurants, there will be numerous kiosks, constructed in accordance with the architecture, styles, and customs of various countries, which will be used for the sale of curios, ornaments, fabrics, and other articles produced and manufactured in all lands.

In the restaurants 6000 or 8000 persons may be comfortably seated and served at one time. Within and about the booths and surrounding platforms 3000 more will have room to move about, make purchases, etc.

The second landing is designated to be a grand promenade and picnic quarters in the day-time and a dancing-hall in the evening. It will accommodate at one time from 5000 to 6000 persons.

The topmost landing will be two or three stories high, and will accommodate at one time from 1200 to 1500 persons. Above this will be four offices for the signal service and scientific investigation. Above these will be the circular electric railway, carrying electric lights at night and signals by day. Still further above will be a lighthouse, to be provided with the most powerful revolving light ever constructed, surmounted by a flagstaff bearing the Stars and Stripes.

THE BLACKPOOL TOWER.

The proposed Blackpool Tower will be almost rectangular in form, with a tower 100 feet square in the center. The base of this will be used as a circus. To the right and left will be large arcades for the sale of jewelry, etc. The second floor will be a spacious promenade concert room and floral hall, having an area of nearly 30,000 square feet, with two stories of open-air balconies and cafés facing the sea. The tower, between 400 and 500 feet high, will be in the center of the plot. It will be of wrought iron and steel, but its sixteen great legs will be formed of square iron lattice pillars, filled and clothed with Portland cement concrete. The building is to cost about $600,000.

THE GIANT SEA-SAW TOWER.

Mr. Oberlin Smith of Bridgeton, N. J., proposes for the Chicago Exposition of 1893 a tower with an oscillating beam, the tower to be permanent, 600 feet high, octagonal in section, and surmounted with a statue of Columbus in sheet metal, 125 feet high.

Pivoted to the tower there would be, during the Exposition, a large oscillating beam, 1100 feet long and 150 feet in greatest width.

STEEL FOUNDATIONS FOR TALL BUILDINGS.

Steel foundations are used for the enormous buildings that are being erected in Chicago. There is first a layer of concrete large enough to reduce the pressure on the soil to one and one-half to two tons per square foot; on this there is placed a number of steel rails or beams, surmounted by a second layer shorter than and at right angles to the first. This is filled by a third and a fourth, each shorter than the one before it, until the base of the columns, which the foundation is to support, is reached. In one case a column with a base four feet square carrying a load requiring 16½ feet square on the soil, would have taken a seven-foot pier of stone, of 691 cubic feet; but this was replaced by four layers of 75-pound rails, reducing the height between the concrete and the column to 20 inches, and the amount of material to 217 cubic feet—saving the space for a basement story.

A Chicago firm recently contracted to have a building, with iron framework and stone and terra cotta filling, put up ten stories high in six weeks.

A steel chimney for the Fair building, in Chicago, will be 250 feet high, and 9 feet 5 inches outside diameter; its thickness running from $\frac{5}{32}$ inch at the top to $\frac{3}{8}$ at the bottom. The weight is 250 tons. A brick stack would weigh 700 tons; and its outside diameter would be 16½ feet.

Monolithic construction is employed in the museum of the great Stanford University, Cal. It will be 300 feet long, 50 in width, with two wings, and three stories high; and will be throughout of concrete and twisted iron.

SLOW-BURNING CONSTRUCTION.

Slow-burning construction seems to have superseded the old idea of making buildings fire-proof; and wood is considered a better material than iron. In mill work the most important items are the floors. The recommendations of Mr. Woodbury, who has had most to do with the investigations in this line, are for floors carried on square wooden columns, eight feet apart, and of a strength sufficient to carry the load; the floor to be of three-inch planks, over which should be laid two thicknesses of asbestos paper covered by one and one-fourth inch planking. Such a floor will weigh 16 to 17½ pounds per square foot. Compound beams are usually found desirable.

Aluminium is to be used in some of the towers in the public buildings of Philadelphia instead of cast iron, thus saving 400 tons in weight and the constant expense of painting.

MINING AND QUARRYING.

THE treasures which exist below the earth's surface may be said to be practically inexhaustible. There are some few which seem at times to become rare, but the intelligence and skill of the expert mineralogist,

added to the experience and ability of the mining engineer, find them in almost unexpected quarters of the earth, and drag them from their hiding-places to serve man's use or tickle his vanity.

An electric dredging and amalgamating machine, which has been tested near Denver, consists of a dredge arranged to be propelled backward and forward by a crew, or on its own track by its own power. Mounted thereon are four electric motors, one of which handles the dipper, another lifts it though the cut, a third swings the dipper to the hopper, and the fourth operates the amalgamator upon the rear of the platform. The dredge handles two dippers per minute in hard cement, gravel, and bowlders, such as are usually found in placer mining. The dipper dredge has a capacity of one-half cubic yard.

A new way of quarrying rock is based on the fact that the direction in which a rock is cleft by a powder blast may be regulated by properly shaping the blast-hole. Thus, to shear a sheet of stone ten feet deep from its horizontal bed in one piece—the face in front being free, and a natural seam separating the block at each end from the walls of the quarry—a series of holes is drilled along the rock parallel to its outer face (say 10 to 15 feet apart in sandstone of medium hardness). If the bed is a tight one, the holes should run clear through the sheet. They must be perfectly round and in a straight line with each other. They are then reamed out to form acute angles at the ends of the diameter which lies in a straight line joining the holes; preserving the ordinary circular section on

the other diameter. On blasting, each of these angles forms the starting-point of a cleavage line running, practically, in a straight line between the holes, and the whole mass may be shifted on its bed by a good explosive, as Judson or black powder. A block of 400 tons of granite was split clean in two with thirteen ounces of FF powder, and a block of sandstone of less than 100 tons was barely started by 2½ pounds of the same. As much air space as possible should be left between the explosive and the tamping. By making in each hole four angular grooves, at right angles to each other, two lines of cleavage may be started.

The demand for 100-ton guns has made one for wolfram, which is now being mined in New Zealand, the ore being scheelite, or tungstate of lime.

It is said that practically inexhaustible veins of silica have been discovered at Friedensville, Pa., and that they are admirably adapted for pottery.

Prof. A. E. Foote, of Philadelphia, read a paper at the Washington meeting of the A. A. S., in which he describes a new locality for meteoric iron, near Cañon Diablo, Arizona ; fragments of the iron containing diamonds. A mass of 40 pounds of the iron was highly resistant to the chisel, and even to the emery wheel; and in certain exposed cavities, black diamonds were found that cut polished corrundum with ease. Troilite and daubreclite were found. The mass was three per cent. nickel.

Several specimens of a new stone have been found in Nevada. It is dark green and susceptible of high polish. The State mineralogist calls it sariscite, or a composition of hydrous phosphate of aluminium. It is rare and is found scattered in nuggets of not more than fifty pounds embedded in silver ore.

A copper mine in Japan, which was first worked 1183 years ago, is soon to be reopened. The mine is in the Musashi province, and it is recorded in old Japanese works that this was the first copper mine ever worked in Japan. It was opened in the fifth year of Keiun, 1183 years ago, and the event was marked by changing the name of the era to Wado (Japanese for copper). Seven or eight of the ancient workings are said to exist just as they were eleven centuries ago, and trial diggings are being made.

ORE-SORTING SHOVEL.

Brunton's quartering shovel consists of a well-balanced flat-bottomed steel shovel, ten inches wide, having vertical sides and two central partitions 2½ inches apart, dividing the shovel into three compartments, the center one being closed by a curved back and having a width one-quarter the whole. To use it, the shovel is pushed into a pile of finely crushed ore. As the shovel is raised it is drawn back at the same time with a sharp rotary motion to the right, which throws the ore contained in the outside compartment out from the back end of the shovel into a rejected ore pile. When the necessary throw to accomplish this result has been given, the motion is reversed and the shovel brought rapidly to the left, discharging

upon the pile the sample from the central compartment of the shovel.

Russian mercury from Saigewa, near Mikitowka Station, on the Azof Railway, has already become an article of export, besides supplying the home consumption.

In Galveston, in sinking an artesian well which is now 2040 feet in depth, gray and green clay mixed with wood, lime concretions, and pebbles were found at a depth of 1510 feet. The age of the wood is estimated at 200,000 years by Professor Singley, and in the stratum, which is 100 feet in thickness, he found seeds resembling apple and huckleberry seeds.

Several mines in the Connellsville region, Pa., have been lighted by electricity. The shafts vary from 100 to nearly 1000 feet in depth. Heretofore, owing to the accumulation of firedamp gas, it has been difficult to illuminate them and avoid the danger of causing fire. The lamps are distributed underground throughout the main walks leading to the shaft.

A new use for the blower is in the removal of slack at the coal mines, etc. There is a positive blast blower, a worm discharging from the slack hopper, and a blast pipe connected with this worm discharge. The operation is on the same principle as that used in the sand blast; and the saving of a small apparatus is $6.00 to $8.00 per day over the horse and cart plan.

The Tonquin coal seams are being explored. One of them is 152 feet thick, of semi-anthracite, containing eighty-seven per cent. of carbon.

Attention has been called to the fact that South Africa may become a rich petroleum-producing country, particularly in the Transvaal.

A recently discovered deposit of mineral wax in Southern Oregon gives ozokerite that burns freely with dense smoke, but no odor. It has nearly all the properties of beeswax except stickiness. The new deposit is yellowish-white, and has low specific gravity.

Mineral oil fields, regarded as practically inexhaustible, have been opened in a region extending three hundred miles east and west from Albuquerque, New Mexico.

Northeastern Siberia has been opened to commerce by an expedition consisting of two ships and a tug, which reached Karaoul, 160 miles up the Yenisei, without accident. Siberia is said to surpass the North American Continent in extent of cultivable soil ; to have the largest forests in the world, and to have immense mineral resources.

A discovery of opals has been made near Moscow, State of Washington.

Reports state that diamonds have been found in paying quantities in Demerara, South America.

Natural gas has been found in Kentucky, in Meade County, 25 miles southwest of Louisville. The Kentucky Rock Gas Company controls the supply.

The first ingots of California tin came from the

Temescal Mines in April last. Oil fuel is used in the furnace.

Antimony has been discovered in Victoria in the form of sulphide.

The coal production of the United States in 1890 was 141,229,515 short tons, worth at the mines, before shipment, $160,226,323, or $1.58 per short ton. The production of bituminous coal was 95,-629,026 short tons, valued at $94,346,809, or 99 cents per short ton.

METALLURGY AND FOUNDRY PRACTICE.

In metallurgy the chemist and the mechanical engineer go hand in hand; each one dependent upon the skill and knowledge of the other, each eager to obtain from the other the solution of some problem which may not be solved either by mechanical or by chemical means alone. In these latter days the electrician, himself necessarily no mean mechanical engineer, is called on to perform tasks that would a generation ago have seemed magical; and which, if offered publicity a very few centuries ago, would have savored of alchemy or of witchcraft.

MECHANICAL PROCESSES.

October 13 there was forged at South Bethlehem the largest steel gun ever made in this country. The work was performed by a Whitworth press, the largest in the world. When the ingot was taken from the furnace and placed on the press, the mam-

moth ram was played rapidly upon it, and it soon grew to the required length. The gun will be a 13-inch tube, and when finished will be 42 feet long. It will be used on one of the new battle ships.

Before the forging of the gun the largest castings ever made in this country were poured. Nineteen ladles, drawn by locomotives, were required to fill the immense mold. The weight of the casting was 150 tons. The work of pouring it was conducted by John Fritz, general superintendent. The ladles were tilted and their contents poured into the mold by a hydraulic crane. The castings will be used for the head of another large forging press which will be four times more powerful than the present Whitworth.

The most powerful steam hammer in the world has been completed during the past year at the Bethlehem Iron Company's works. It strikes a 125-ton blow, and is to be used for forging ingots into armor plate. The ingots of metal weigh from 100 to 150 tons each, and they will be forged into desired sizes with great ease by the pounding of this enormous hammer. This hammer takes the championship honor away from the 100-ton giant hammer at the works of Schneider & Co. of Le Creusot.

By a new German process, hollow forgings in iron or steel are made from solid blocks of red-hot or white-hot iron or steel. To produce a hollow cylinder, a piece of hot square metal is taken, the cross section of which, diagonally measured, corresponds to the diameter of the hollow cylinder to be produced, and a pointed core bar is then driven into the metal by

means of a hammer or press, the lid of the matrix forming a guide for the core bar. When desired, the matrices may be formed with jackets in which circulates a cooling medium. The metal is thus forced to fill the cylindrical matrix, and has an opening through its center in the direction of its length. Hollow prismatic bodies may be produced in a manner similar to that which has been described, an important condition being stated to pertain to all cases. namely, that the metal to be operated upon shall be truly centered by the matrix. For hollow bodies of unusual length two core bars may be employed, entered into the metal from opposite ends; and when steam hammers or presses are used, their frames may form guides for the matrix.

Recently a new rolling mill has been added to the Krupp works which, it is stated, is not surpassed by any in the world. It is for rolling armor plates, and turns out the heaviest plates of this description that can possibly be required: that is, those of about 28 inches thickness and nearly four yards wide. Each pair of crucible rollers, when in the rough state, weighed 100,000 pounds; and the entire rolling mill, with its reversing engine, the large furnaces, the cranes that can move 300,000 pounds, its bending presses, etc., form of themselves almost a complete plant. Immense shears cut through the plates as easily as ordinary shears cut through paper, and extremely thin plates are also produced. Automatic tackles are employed for raising and lowering the plates in their passage from one set of rolls to the other, and automatic devices for guiding them as

they pass between the rollers or are taken from them. So automatic is this process that, without the aid of tongs or levers, the plates move back and forth between the rollers.

Charles Weston Smith read a paper before the Royal United Service Institution on "Steel as Applied to Armor Plates," in which he proposes to make a steel plate having the advantages of compound plates and those of all steel plates also. This is to be done by casting, varying the sequentiated tempers of steel simultaneously in one ingot mold, so constructed in subdivisions that the varying tempers shall be preserved, each in its integrate, while yet each shall so combine with the other as to form a perfectly graded whole, the rolled steel partition plates, which subdivide the mold, constituting a steel armor-plate ingot.

Hydraulic compression of ingot steel receives less attention than warrantable, the rejection of so much of the average ingot as "pipe-end" being a great source of waste and reduction of daily mill capacity.

The rolling of hollow stay bolts is an industry recently introduced, and claimed to possess special advantages. Two pieces of iron, rolled in U-shaped section, are laid together and wired in that position, these parts being then heated to a welding heat and run through rolls, and as the welded tube comes from the rolls it passes over a mandrel. Before reaching the second pair of rolls it cools slightly and shrinks upon the mandrel, and in this pair of rolls it is drawn from the mandrel and the interior cleared. In this way, by

five repeated operations, there is obtained a hollow stay bolt of uniform interior diameter. The material must necessarily be the very best quality of charcoal iron; the bolts are made in lengths of six feet. It is claimed that a considerable saving in expense is made by using the hollow stay-bolt iron, instead of drilling the ends of solid bolts after they are in position.

Bessemer is experimenting on the manufacture of continuous sheets of wrought iron and steel direct from fluid metal; and some of the conclusions at which he has arrived are given in a paper before the Iron and Steel Institute. His present plan consists in having an immense pair of horizontal rolls having water circulation, and between which fluid steel is poured from a crucible. The sheet falling between them runs, after a short passage in the air, between a pair of horizontal rolls, the axes of which are in an inclined plane, and then between a pair of ordinary horizontal rolls having their axes in a vertical plane. The process dispenses with the cost and wear and tear of casting molds, the labor of their removal and re-arrangement at each casting operation, the need of soaking pits or reheating furnaces, and the cost of labor and fuel for these last. Thin sheets so produced are free from scale; and as there is no overlap of the plates in rolling, there is but little loss of metal in shearing.

A new tuyère iron permits a burnt nozzle to be replaced without disjointing the water connections. This is effected by ground metal surfaces between the tips and the base, both in the inner and in the outer

tube, the tip being bolted to the rest of the nozzle through lugs.

Tire-rolling from ingots is being accomplished with great success in England by Munton, as reported by S. Higgins of Bradley Grove, Rotherham, England. The work of making tire blooms from ingots is accomplished at the rate of forty per hour, all day long. A tire can be rolled from a bloom 6½ inches wide, and finished 9½ inches wide to perfect section. A 1200-pound bloom can be rolled out to five feet diameter, and the process reversed and the metal rolled back to a bloom in two minutes, then rolled out again to finishing size, all at one heat.

An instrument for detecting flaws in castings, etc., consists of a small pneumatic tapper, worked by the hand and connected with a telephone and microphone. It is called a sciséophone.

The forgings necessary for the Fall River Line steamer *Puritan* are the largest ever made in the United States; being from 28 to 30 inches in diameter and over 36 feet in length, and weighing, finished, over 75,000 pounds each.

Tests of nickel-steel armor plates at Annapolis show its superiority over ordinary steel for this purpose.

A new method of planishing pipes and plates is by the suspension pneumatic power hammer made by Thwaites Bros. There are two belt-driven disk cranks,

connected with a hollow steel arm by a connecting rod. The arm is divided inside into two compartments, each having a phosphor-bronze air piston, and which are connected by a steel piston rod, the top air piston forming a connection for the small end of the connecting rod. The machine delivers 500 blows per minute. The rod to be planished is held in journals on two carriages. When a pipe is to be worked it is held upon a mandril supported between the two carriages. Pipes up to four feet in diameter may be worked.

Messenez has described an apparatus for taking sulphur from pig iron in masses of 70 to 120 tons; sulphurated pig iron, poor in manganese, being added in a fluid condition to manganiferous molten pig iron poor in sulphur; the result being to take the sulphur out of the iron and make a manganese sulphur slag.

Carulla has shown that the interior of a piece of mild steel may be raised to the fusing point, while the outside remains in a solid state; this being made possible by the outside becoming decarburized.

Iron and steel plates are now lead-coated, the lead bath being 98½ per cent. pure. The plates are first pickled, electricity being called in to hasten the process; then the plates are passed into lime water, next into clear water; then into a bath of neutral solution of zinc and tin chlorides; next into a steam drying chamber which leaves on them a coat of the chlorides to protect against oxidation. Then the plates are passed into the lead bath. The coating

may be made as thin as two ounces per square foot of plate.

On the night of July 6, 1891, the second turn in the converting department of the Edgar Thomson Steel Works at Braddock made 60 heats, and turned out 930 tons of steel; the best previous record being 850.

Kupfelweiser has put into operation a modification of the open hearth process of steel-making, by which he uses molten iron from the blast furnace. The charges consist of 90 per cent. of cast iron, and 10 per cent. of scrap, with the necessary ore for tempering, and lime for dephosphorizing.

The furnace which Palmer's Shipbuilding and Iron Company, Limited, put up at Jarrow-on-Tyne, is virtually an American one as regards its lines and method of working; being an exact copy of the most recent one at the Edgar Thomson Works of Carnegie Bros., a furnace which has produced up to 2500 tons of pig iron per week, this being more than double the output of the best English hematite furnaces, nearly five times as much as the ordinary Cleveland furnace, and almost twelve times as much as the average Scotch furnace.

Still, as it has to work upon only a 50 per cent. ore, it will not be able to do so much as its mate in America, which gets 60 to 63 per cent. ore, of a much less refractory type.

ELECTRICAL PROCESSES.*

Hopfner proposes to extract silver and copper from other ores by electrolyzation. He uses a bath which is divided into compartments by diaphragms. In one compartment there are electrolytically insoluble anodes, and in the other copper cathodes. A double salt of copper chloride and a halogen salt circulates around the anodes, and a similar solution around the cathodes. On the copper, sponge copper is deposited at the rate of 2.38 grams per ampère-hour. As the liquid passes the cathode, it parts with its copper and is available for use again ; but the copper is present as cupric instead of cuprous chloride, aud the latter is made to leave the bath in a continuous stream.

At Lauffen Neuhousen, on the Rhine, there is a works for the manufacture of aluminium, run by the Aluminium Industry Company, Limited, of Zurich. The process consists in the action of an electric current upon cryolite.

The two larger aluminium machines are constructed to develop 14,000 ampères of current at thirty volts, or 420,000 watts, working day and night ; but the power may be increased to 500,000 watts.

Dixon has manufactured aluminium by the electrolytic decomposition of a molten halogen salt, one of the elements of which is caused to react upon the oxide, or other suitable compound of the metal, or of a suitable mixture thereof with carbonaceous material,

* See also under the various Electrical headings, pages 241 to 307.

while the other element of the salt acts on the resulting compound.

Soldering aluminium is now accomplished with tolerable ease, by the employment of sheets of the metal, or of an alloy thereof, that may be soldered with an ordinary soldering iron and thin solder. The line of joint is prepared by a mixture of resin, tallow, and neutral chloride of zinc ; scraping being avoided. But any sheet aluminium may be readily soldered if previously given a light plating of copper. If, however, it be suddenly heated the copper will strip off. Aluminium bronze containing five per cent. of aluminium may be soldered with ordinary soft tin solder ; but the more aluminium there is, the more difficult the operation.

Hard soldering offers no difficulties. A good solder is made by smelting fifty-two parts of copper, forty-six of zinc, and two of tin ; borax being the flux. Tubes made from sheets soldered with this may be drawn down on a mandrel.

NEW ALLOYS.

J. W. Langley has found that if pure aluminium be alloyed with from one-half per cent. to ten per cent. of titanium, the result will be harder than aluminium, nearly as uncorrodable, and capable of acquiring by hammering or rolling a greater elasticity and hardness than the pure aluminium. These alloys are fusible below the melting point of steel. When there is less than five per cent. of titanium, the alloy is nearly as malleable as pure aluminium.

Experiments have been made at the Forges de Montataire, with a nickel and iron alloy having the following composition ; carbon, 0.15 to 0.05 ; phosphorus, 0.02 to 0.05 ; nickel, 25 per cent.; iron, 74 per cent. Round bars, 0.58 inches in diameter turned to 0.47 inches in diameter, had, when unannealed, a tensile strength of 56.6 gross tons per square inch, with an elongation of 19 per cent. in 8 inches. Thus, after annealing, the results were : tensile strength, 51.5 gross tons per square inch ; elongation, 29.5 per cent. in 8 inches.

The Stefanite process aims at introducing aluminium into iron, either in the blast furnace, the cupola, or the puddling furnace. During the process of manufacture the liberation of aluminium goes on at the same time as the manufacture or the melting of the iron ; the newly formed metal being instantly alloyed with the iron. The intention is to take advantage of the effect that aluminium has of lowering the melting point and increasing the fluidity of iron.

The process consists in an addition to the iron ore, or to the pig, of emery and alum.

Held has produced a new gold-colored alloy of copper and antimony, in the proportion of 100 to 6, using a flux of wood ashes, magnesia, and carbonate of lime. It can be rolled, forged, and soldered in the same way as gold, and is not tarnished by ammonia and acid vapors. It is said to cost 25 cents per pound in the ingot.

In a discussion before the British Institution of Mechanical Engineers, Hatfield stated, as an approxi-

mate classification in the light of experiments on steel made up to date, that no amount of experiment or theory would get over the fact that carbon alone produced water-quenching hardening; that is, conferred upon iron the property of becoming hard when water-quenched, and of causing sufficient hardness to scratch glass or form the cutting-edge of a tool. Nickel and manganese, when added in sufficient quantities, strongly toughen iron, but do not confer the property of water-quenching hardness. Chromium and tungsten toughen iron, but act much less powerfully than nickel and manganese.

Aluminium, silicon, sulphur, phosphorus, arsenic, and copper, while agreeing in their general properties of not conferring hardness upon iron, may be divided into two sections. Aluminium and silicon in one section do not act so powerfully in destroying malleability and toughness as the others, but this is a matter of only degree. The others, when present in but small quantities, destroy malleability and ductility either in the hot or in the cold state. Phosphorus produces a similar effect, but may be present in larger quantities before red-shortness occurs; causing serious brittleness in the cold state. Iron will not alloy with lead and tin. The addition of cobalt did not give hardness.

Experiments of the French government show that an alloy of aluminium with six per cent. of copper is twice as strong as pure aluminium, and only six per cent. heavier.

Aluminium in steel ingots has been shown to have

the property of making them tough and sound, by reason of its occluding carbonic oxide. Arnold blew 40 gallons of carbonic oxide through a crucible of molten steel containing aluminium, with the result that the carbon in the steel increased thirty-five per cent. owing to the reduction of the gas by the aluminium.

Manganese steel is proposed for bridge-pins, by reason of its remarkable wear-resisting powers. The trouble would be to cut threads upon it. They would have to be forged upon the pins.

A new manganese bronze is an alloy of iron, copper, zinc, and manganese ; it has a red gold color, takes a good polish, and resists acid, sulphur, water, and sea water. Its tensile strength in a casting is 60,000 to 65,000 pounds per square inch.

What is claimed to be a most valuable alloy has recently been brought to notice, the constituents of the same being copper and antimony, in the proportion of 100 to 6. The process of production consists in melting the copper and subsequently adding the antimony, and, when both of these are melted and intimately mixed, fluxing the mass in the crucible with an addition of wood ashes, magnesium, and carbonate of lime, which has the important effect of removing porosity and increasing the density of the metal when cast. The alloy can be rolled, forged, and soldered in the same manner as gold, which it very closely resembles when polished, the gold color being unchanged even after long exposure to ammonia and acid vapors in the atmosphere. The cost of this

alloy in the ingot is said to be about twenty-five cents per pound.

Several new alloys have been invented recently. They are nickel-aluminium, for decorative threads; zinc-nickel, for a pigment; platinide, composed of platinum, nickel, gold, and iron, for crucibles and chemical utensils; roseine, composed of nickel, silver, aluminium, and tin, for jewelers' work; sun-bronze, composed of cobalt, aluminium, and copper; metalline, composed of cobalt, aluminium, iron, and copper.

FOUNDRY PRACTICE.

The largest casting ever poured in the United States was made October 13, at Bethlehem, Pa., being part of a machine which will be used in the manufacture of war material for the Government. It will weigh, when finished, 330,000 pounds.

In Richard's process of casting steel car-wheels the mold is so arranged that the metal will overflow through the hub bands before the rim is entirely filled, and before the feeding rim is entirely finished. That result is obtained by making the hub opening to have less resistance than the rim vents. The overflow at the hub is intended to dislodge and carry out of the metal certain impurities; but at a certain point it needs to be checked to prevent the latter feeding of the rim.

Mr. David Spence says that he has used aluminium in foundry practice, and found it excellent to make

iron fluid and clean ; taking out all the impurities when it is charged in the cupola with the pig iron. Ten pounds of Cowles' ferro-aluminium to 2000 of pig iron will produce good sound castings, free from blow holes. He says also that it is as good in the case of crucible steel as with iron ; producing a sharp and solid casting, and making a uniform grain. It takes away the tendency to chill in casting iron. In steel it reduces the shrinkage and increases the welding properties of both wrought iron and steel. It does not weaken the iron, but strengthens it.

Carbon cores are now supplied for casting, instead of sand cores ; being smoother and tougher, and keeping any length of time. They are perforated lengthwise.

The art of casting large statues of bronze in one piece, as practiced by Benvenuto Cellini in casting the "Perseus," and which has been a lost art, has been rediscovered ; being the *cire perdue* process. From the clay model a plaster reproduction is made ; from this matrix, which is furnished with a core, the matrix being coated with wax of the thickness desired for the bronze, a mold is made, then heated, the wax running out and leaving space for the bronze to be poured in.

Molding-sand has been found to be much improved by being mixed with a centrifugal mixer instead of being simply riddled ; as the particles of clay or groups of sand grains are so thoroughly disintegrated and mixed with the coal dust, that the gas generated in the mold can get around every particle of sand and

escape easily and equably, which is a desideratum in fine casting. The centrifugally mixed sand is also much tougher than that which is riddled.

The manufacture of tin plate articles is to be tried by Norton Bros., Maywood, Ill., by making the articles of sheet iron and tinning them when finished.

It is said, on the authority of the Philadelphia *Record*, that an establishment near Front and Laurel streets, Philadelphia, turns out 20 or more boxes of terne plate per day. The N. & G. Taylor Co., of Philadelphia, is the firm that is making the experiments.

Tin or rather terne plate is said to be made in the United States; but there is no indication that the required supply (about 369,000 tons, of the 562,000 tons needed by the world each year) will be made here for some time to come.

A development of the pig iron trade in this country is the establishment of a pig iron storage yard, which issues certificates of deposit which are saleable by transfer, the same as so much iron. One company has over twenty of such yards in Virginia, West Virginia, Kentucky, Tennessee, Georgia, and Alabama. At one time the amount stored in all was over 55,000 pounds.

The discovery of natural gas in the Cleveland district (England) should prove of enormous advantage to the chemical and metallurgical industries carried on in that famous section.

Palladium is now used considerably to plate watch movements, being whiter, lighter, and more fusible than platinum. About $\frac{1}{17}$ grain is enough to coat the works of an ordinary sized watch.

The peculiar weakness of iron and steel at a blue heat has been brought to the attention of railway men, and named blue-shortness. It is an old complaint, but attention has been brought to it in connection with damage done by working at such temperatures in recent important constructions.

The experiments with armor steel at Annapolis resulted in the classification of the three kinds of plates in this order of superiority: nickel steel, all steel, compound.

The Steel Pipe Company, of Kirkcaldy, is doing much to show the superiority of steel pipes over wrought iron.

The Master Car Builders have had tests made of the strength of malleable iron, and find it to run from 28,200 pounds, on a sample 1.52 by 1.54 inches, to 34,700 in one 1.52 by 6.25. The elongation was from one to two per cent. in four inches. The ductility is seen to be low.

Tests made as to the comparative rusting of iron and soft Bessemer steel show iron to lose 2.06 per cent. of its original weight, and steel only 1.79 per cent., in sixty-one days, having been taken up once in that time and cleaned.

MACHINE SHOP PRACTICE.

NEW SHAPING AND PLANING MACHINES.

THE past year has witnessed the development of the screw shaper, into several convenient forms. The first shape in which we knew it was in the Richards open side planer and shaper, in which the saddle was carried along by a rapidly moving screw and reversed by striking adjustable tappets placed along on the rod ; the rotation of the screw being accomplished by high speed pulleys and shifting belts without the use of gearing ; the work being fastened and the tool and saddle being the moving parts as in the old-fashioned pit planer. One heavy form of the machine, for plate scarfing or planing, has two traveling heads, one at each end of a stationary bed or table, and each driven independently by a separate countershaft so that wide plates may be planed or spotted off, using at will one or both heads, or long or short stroke. The table is made to swivel or set at certain angles by a screw and hand wheel, to increase its convenience in scarfing steel ship-plates, for which purpose the machine was specially constructed. The operator stands in front between the bed, where both belt-shifters and all hand wheels are easily handled.

Another machine, employing the same principle of the high speed belt driven screw and the traveling saddles bearing head, is the shaper proper, which planes up to 30 inches long, a column machine having an adjusting table to which the auxiliary table will bolt when desired ; this smaller table being removable and leaving an angle plate to which long pieces may

be bolted. The table is raised and lowered by a crank and screw. The tool slide, which has downward feed by hand, and cross feed by power, is on a swiveling base so that angle work can be planed. While siding down or doing angle work the tool slide may be locked fast. The speed of this tool, as of all others employing the screw motion, is the same at all parts of the stroke. The length of stroke may be altered while the machine is running.

A planing machine, made by Bertram of Montreal, has under the bed a rack, driven by a pinion, the shaft of which bears a worm wheel driven by a worm, the direction of motion of which is reversible by shifting belts.

A new style planing machine, made by Berry & Sons, Saverly Bridge, England, has its back standards intended to be bolted to a wall, or to a timber framework. A surface measuring 12 by 12 feet may be machined at one setting.

RECENT MILLING MACHINES.

A plain milling machine, brought out during 1891 by Brown & Sharpe Mfg. Co., is in many respects similar to their universal milling machine, but without provision for cutting spirals, as the platen moves at right angles to the spindle; and there is no spiral head or footstock. There is an overhanging arm, which provides for either a center or outer bearing for the arbor. This arm is a brace by which it may be readily connected to the knee.

The Pratt & Whitney Co. has brought out a milling machine for removing at one operation the superfluous metal in making a wrought iron or wrought steel I-section connecting rod. In a recent trial this tool took a cut $3\frac{1}{2}$ inches wide and $1\frac{3}{16}$ inches deep in the groove, and one $4\frac{3}{4}$ inches wide and $\frac{1}{8}$ inches deep at the top. The feed was $1\frac{3}{4}$ inches per minute, so that the machine took off eight cubic inches per minute. In cast iron the same machine has taken off $9\frac{1}{2}$ cubic inches per minute. The cutter spindle is $5\frac{1}{2}$ inches in diameter in the front journal and 10 inches long.

DRILLING MACHINES.

A very radical departure from the usual line of design in radial drills is the construction and arrangement of the arm, which is cylindrical and made to slide through a sleeve bearing at the top of the vertical column, the drill spindle being adjusted to and from the column by sliding the arm through this bearing instead of having a sliding carriage or head fitted to the arm. Attached rigidly to the bed plate there is a stump which is turned true outside, and has fitted to it the vertical column. This column may be raised and lowered on the stump by a vertical screw at the side, which is driven by power and engages in a nut attached to a ring, on which the head of the column is supported when unclamped. The arm is moved in and out through the bearing in the column by a screw driven by a crank and gears.

A swing jib countersink drilling machine, made by Jones, Bouton & Co., 19 Castle St., Liverpool, is in-

tended to countersink all the holes in a plate 16 by 5 feet, without any movement of the plate. The drill spindle may be moved laterally on a swinging jib attached to the wall or to columns, and the spindle may be moved in and out, toward or from the center of swing.

GRINDING AND POLISHING MACHINES.

Tool-grinding machines are becoming more and more common, the number of classes of manufacturers that use them, as well as the mere number of such machines made and sold, increasing. This introduction has been despite the difficulty that, when tempered tools are ground, it has been found necessary to rotate them at comparatively slow speed or else to use water with them, to keep from drawing the temper of the tools; and the application of water is not always convenient, by reason of its flying off by so-called centrifugal force when the wheel speed is rapid. One means of catching water and applying it again and again to the wheel, which has met with considerable favor during the past year, is to apply the water at a point near the center of the stone or wheel, capillary attraction causing it to stick to the surface and accumulate until the motion of the wheel makes it fly toward the largest diameter, where it is met by a case and conducted again to the tank. The faster the wheel is turned, the more rapidly the water flows, permitting the rate of wheel speed to be greatly increased. An upright form of such a grinding machine has a vertical axis and a wheel with its grinding face slightly beveled, to suit the grinding of long knives, which have to lie across

the wheel from one side to the other. It is particularly adapted for grinding wood-working tools having straight edges. The water is brought to and carried over the surface of the wheel, and back to the tank, by so-called centrifugal force.

Another modification of the same principle is a gouge and cutter-grinder, which has a horizontal conical grinder for grinding the inside of tools having concave cutting edges; working all tools to a true circular arc.

A new twist-drill grinder is for the purpose of swinging the drill laterally and radially, at the same time that it is turned in grinding. It may be attached to an ordinary grindstone, and is made by Edmeston of Manchester.

A surface grinding machine, brought out by the Brown & Sharpe Mfg. Co. during 1891, is for finishing small parts of machinery, tools, dies, punches, etc. The wheel is mounted upon a slide which has vertical traverse, and the table which bears the work is given lengthwise or crosswise travel, in both cases automatically; the lengthwise travel being limited by stops which can be set to suit the operator. Either of these motions can be made by hand with hand wheels. The table permits of a small pair of centers being fastened to it, to permit sharpening and finishing the grooves of the taps, reamers, etc. There is an adjustable swiveling vise which will swing in either direction 45° from the horizontal.

The same establishment has introduced a new pattern of universal grinding machine, suitable for

both straight and taper internal and external grinding. In this there is a sliding table which moves on one V and one flat slide, and which carries the head and foot-stock, so that the machine may be set for taper grinding or straight, at will, without its centers being thrown out of line.

For heavy work the swiveling table is clamped to the sliding table; but for ordinary work the head of the table gives sufficient stability without clamping.

An adjusting screw and scale enable the table to be set to the desired taper and show the amount in degrees, and also in inches per foot. The wheel bed rests upon a rearward projection of the base, which extends to the floor and stands upon one of the three feet by which the base is supported. The circumference of an arc, at the lower edge of the wheel bed, is graduated to degrees, so that it may be set at any desired angle relative to the sliding table. The wheel plates rest upon a thick circular bearing, the mean diameter of which is greater than the distance between the wheel spindle bearings, this providing a steady support for the wheel stand and doing away with rocking. The wheel stand and adjoining parts are rigidly connected with the rearward projection of the base to do away with vibration of the wheel; the feed of the table is positive, and it can be moved by a hand wheel if desired. The table is reversed by a lever worked by dogs in the same way as upon a planer; and there is a special contrivance for very delicate adjustment of stroke length. The cross feed is worked by a hand wheel having graduations to 5–10,000 of an inch. The head-stock swivels upon the

center pin, and its circumference at the lower edge is graduated in degrees. Work may be ground upon two dead centers, or upon one live and one dead center, or may be held in a chuck upon the head-stock. Either internal or external tapers may be ground without changing any of the settings.

Altogether this machine is of a character to be specially desirable and useful to those having much work with cylindrical or conical surfaces requiring to be exactly sized and finely finished, as, for instance, in the manufacture of tools and gauges and small parts of machines.

A very convenient polishing wheel stand designed by the Brown & Sharpe Mfg. Co. has a hollow vertical column and such a form of wheel guard that the draught caused by the rapid movement of the wheel carries the larger part of the dust, produced by grinding, from the operator to the bottom of the stand. This may be connected with a blower.

MISCELLANEOUS TOOLS AND MACHINES.

A large vertical cylinder-boring machine, built by Sellers & Co., for the Newport News Ship Building and Dock Co., has a boring bar 16 inches in diameter, with heads for boring cylinders up to 108 inches in diameter; and also with a double face and head, each having a compound slide rest to face 120 inches in diameter. The vertical standards are 13 feet apart, and the height from the sole plate to the inner side of the boring head in position, 10 feet. The boring bar can be lifted out through the top bearing without disturbing the driving gear or

the feed gear. The feed is automatic, and may be thrown out at any time by a hand lever, and the boring or facing head may be moved slowly in either direction by the hand lever, or quickly by power by reverse-friction clutches. A small horizontal high-speed engine is attached to one of the standards, and carries on its crank shaft a cone pulley to vary the boring-bar speed. The machine weighs 117,500 pounds.

A helix-forming machine, made by Watson, Laidlaw & Co., is for giving a helical form to straight bars. They are bent by passing them through a series of rollers, preferably three. One of them is carried on the end of a shaft; the upper or neck bearing of this surface is an axis for a turntable, which carries one of the rollers at a determined distance from the revolving center of the turntable. The third roller is on a short shaft running on a bearing cast on the framework and placed just underneath the turntable. The roller carried upon the turntable may be moved into any desired position relative to the other two, to obtain the required curve. Suitable grooves are made in all the rollers to suit the section of the bar.

A pneumatic tire-hammer, built by the Kalker Werkzeug Machinen Fabrik, of Kalk, near Cologne, Germany, is for fixing in place the tires of railway wheels. The ring is secured by hammering down the edge. There is a strong standard, carrying a fly-wheel, fast and loose pulleys, and a crank wheel, which by means of a rod works a piston, fitting near-

ly airtight into a cylinder attached to the standard. A second piston, carrying the tup, enters the lower part of this cylinder, leaving a free space between the two cylinders. The lower portion of the cylinder, in which the tup piston travels, makes an angle with the power. The smaller sizes give 500 blows per minute.

A new cold saw for metals has been introduced by Carnegie Brothers. It is a circular saw of fine steel, hard tempered ; one-quarter inch thick at the rim, less in the center. It cuts but one inch a minute. The work is stationary, and the saw is traveled along the table. It runs in a solution of ten pounds of whale oil soap, fifteen of sal soda, two gallons of lamp oil, and enough water to make forty gallons.

A new portable rail saw is driven from the circumference, the driving gear engaging back of the teeth. It will cut a 70-pound rail in from eight to twelve minutes. The machine weighs 140 pounds.

A boiler tube expanding machine for locomotive work has a vertical column mounted on a wooden platform carried on four truck wheels. On the column is a cross-head holding a mechanism which drives a universal shaft. The cross-head is raised and lowered by a crank. Power is derived from a stationary engine or from any convenient shafting. Rail clamps hold the machine in position in front of a locomotive. By it 262 tubes were expanded at both ends, ready for beading, in five hours, including the changing of the machine from one end of the belt away to the

other. The machine may also be used for drilling and tapping stay-bolt holes, etc.

A very useful chucking machine is of the vertical type, the work being chucked upon a horizontal table, with a turret head sliding in vertical ways, so that once a piece is chucked, five tools may be used upon it without further adjustment. The feed is automatic, and has ample range of speed. The turret slide is counterbalanced by a weight inside the column, and has quick return motion by hand. In this machine the spindle cannot wear out of line with the turret slides ; the work is easily trued and fastened in place, and the chips falling through the center of the spindle to the floor do not clog nor dull the tools.

A new form of micrometer caliper, for measuring the external diameter of screw threads, is similar to the usual Brown & Sharpe micrometer caliper, but one of its points is sharp, so as to reach about to the bottom of the screw thread, and the other a loose piece shaped to conform to the thread of the screw to be measured ; this latter piece fits over the thread directly opposite the place touched by the sharp point. Thus the measurement is given from the bottom of one thread to the top of the opposite one, and this will be equivalent to the diameter of the pitch circle.

The Circlip is the name of a device to fulfill the office usually performed by split pins. It consists of a steel ring sprung into a groove on the shaft or pin which it is desired to secure. The ring is a part of a cone, its wider end projecting above the groove

and the general surface of the shaft, and forms an abutment preventing endwise motion. It may be sprung into place with the fingers, and removed by a pointed piece of wire. When it is placed next a loose pulley, there is required a washer which has in it a pin which takes into the opening in the "circlip."

NEW HOISTING BLOCK.

A mechanism which, while it has been two or more years in developing, has been introduced during 1891, is the Weston triplex spur gear block. All the mechanism is grouped symmetrically upon a single horizontal axis, with as little vertical height as possible to increase the maximum amount of hoist. The power is applied to an endless chain passing over a sprocketed chain wheel on one end of a central shaft, and is transmitted thereby to spur gearing contained in a housing on the other side of the block. There are two chains; one for hoisting and the other for releasing. The main load chain passes over a sprocket chain sheave in the center of the block, one of its ends having a suitable hook for receiving the load, and the other being looped up and permanently fastened to the block frame. This arrangement diminishes the length of slack chain, prevents it from fouling, and adds much to the general convenience of the block. A hand wheel carries the power though the central shaft to a steel pinion at the opposite end, which in turn engages with three planet wheels surrounding it. These latter are of hard bronze and have cast with them a series of similar pinions, which will engage with an annular gear cast in the stationary frame of

the block. The three double planet wheels are carried in a frame or cage which supports both ends of each of the pins forming the axis of the wheels. As the central shaft is turned, the whole cage and its three pinions thus rotate slowly within the housing of the block.

The inner side of the pinion cage consists of a disk, keyed to one end of the wheel sleeve forming a part of and carrying the hoisting chain sheave, so that the rotary motion of the pinion cage is carried to the chain sheave.

The two hubs of the latter are prolonged to form bearings on each side, in the frame of the block, and are bored through the center to let the shaft of the hand-chain wheel pass through the sleeve just formed. This mechanism is not self-sustaining under load; the sustaining of the load and its lowering being accomplished by a separate mechanism. The hand-chain wheel is screwed on the sleeve keyed to the central shaft. When power is first applied to the hoist, the effect is to screw the hand wheel against a series of friction plates, which in turn bear against a disk rotating with the central shaft, and carrying with it a roller check mechanism fitting into a recess formed in the left-hand frame of the block. So long as hoisting continues, the small steel rollers of the checking mechanism offer no resistance; but when hoisting ceases and the load causes reversal of movement, these rollers mount on their inclined path and frictionally check the frame which carries them, preventing its further rotation. This frame in turn locks one set of friction disks and prevents them from turning; the other set of disks, being frictionally engaged

with the first, also remain stationary, and by their friction prevent the hand wheel turning backward. Thus the load is automatically sustained, and cannot be run down unless power be applied to the hand chain.

One of the most remarkable features of this block is that it returns in useful work 79.5 per cent. of the effort of the operator, while that of the best previously done is not over 33⅓ per cent. As most hoisting devices depend upon their internal resistance to sustain the load, it is theoretically impossible for them to obtain a higher efficiency than 50 per cent.

NEW GEARS AND MODES OF GEAR CUTTING.

A new mode of gear cutting is proposed by Mr. Ambrose Swazey, of Cleveland, O., who read a paper about it at the Richmond meeting of the American Association of Mechanical Engineers.

By this means, instead of all gears being made so that they will run into a rack, the rack is transformed into a cutting tool, and by it the teeth of wheels of any diameter are generated and cut at the same time. The cutting tool is composed of a series of cutters rigidly connected, which revolve and at the same time move lengthwise or endwise at right angles to the axis of the wheel to be cut, and at the same speed; it is continuously revolving at the pitch line, the motion being the same as in the case of a rack engaging with a revolving gear. As it would be impracticable to continue moving the whole series of cutters endwise, they are bisected and these segments are connected in series, forming two sections, which revolve upon a common axis, and each section is given independent endwise motion by a cam. While one section is cut-

ting, it is carried endwise in the same direction and at the same velocity that the pitch line of the wheel is rotating, until disengaged from it, when the cutters, while continuing to rotate, are carried by the cam back to their original position, ready for the next tooth. The head carrying the cutters is automatically fed across the face of the wheel, and when the cutters have proceeded once across, the gear is completed.

If their cutting portions are cycloids, then the whole set of gear wheels cut with them will be of the epicycloid or double curve system. If they have straight sides, then a set of involute or single curve gears will be generated and cut.

As by the Willis theory all gears are cut to run with a rack, so by this process the Sang theory is put into practice, and the rack is made to cut correctly all gears.

NEW KEYING SYSTEM.

The machinist has had produced for his benefit a new keying system to take the place of the old method of planing and shaping key beds out of the shaft, filing keys to fit the key beds and further filing the keys to fit the key-way in the boss of the gear or pulley which is fitted to the shaft.

The system consists in an automatic machine for making a suitable key bed, and in a method of making the keys in large quantities and at low prices, and in an interchangeability of keys and of beds.

The key beds are cut by rotating tools, which make a recess in the shaft, of rectangular section with round ends. The keys are inserted in the shaft about three times as deep as is usually the practice ; and by

a cam arrangement a wide range of key beds is got, using different diameters of milling cutters to suit the key thickness. The machine being set for any sized key, the only skill required is to put the shafts into the chuck. On large shafts a standard slot-drilling machine is used. The keys are of a hard grade of cast steel, are much thinner than usual, and are inserted very deep in the shaft.

In carrying out the system in the works, the drawings are marked, at the place where they are to be inserted, with the number to indicate the size key to be used. This number is stamped by the fitter on the shafts, as is also the position of the key. The makers are Messrs. George Richards & Co., Broadhead, near Manchester, England.

IMPROVED WOODEN TOOTH WHEELS.

A wooden gear wheel intended for street railway motors is made by casting a core in one solid piece, and boring and turning it to the diameter the wheel is to be at the bottom of the teeth ; it is then put in a gear cutter and the spaces for teeth milled in its rim ; then wooden teeth are driven in with white lead, the wheel is turned to diameter in the lathe, side plates are put on, the wheel again put in the milling machine, the latter speeded high, and the wooden teeth properly cut. Then the wheel is taken apart and cleaned, and the teeth given a coat of boiled oil, after which the whole is again put together. The large spur wheels thus made are used with steel pinions.

MONSTROUS GEAR WHEEL.

The Walker Mfg. Co., of Cleveland, O., has produced a monstrous spur gear with 192 teeth, 30 feet

$6\frac{3}{8}$ inches pitch diameter, 30 inch face, 6 inches pitch, 27 inches bore; rim diameter, 110 inches; hub weight, 15 tons; total weight of gear, $66\frac{3}{4}$ tons. The gear, with the steel pinion, was the only part of the massive pumping machinery (for South Africa) which was made in this country. An extra arm and segment were sent out with it.

A French system of gearing has the teeth made half of wood and half of metal, the metal halves of the teeth upon one wheel bearing on the wooden halves of the others, and *vice versa.*

FOR FACILITATING MACHINE ERECTION.

A test indicator, brought out by the Brown & Sharpe Mfg. Co., is intended to be of use to those erecting or inspecting machinery, and permits the determination of the degree of inaccuracy of a plane surface on the top, bottom, or side of a piece of work, or of ascertaining the amount of end movement of a spindle, or the extent to which it runs out of true. There is a straight bar or block having T-headed slots throughout its length; and to this an upright post or stand may be clamped at any point by a knurled nut. Upon this post there is a sleeve bearing an arm, which may be fastened at any height on the post, or turned around the post to bring the arm to either size. The arm turns in the sleeve, and may be set at any angle relative to the base; or it may be inverted so that its point may be brought in contact with the work in a downward position. An index finger magnifies many times the movement of this point, and its movement may be read upon graduations at one end of the

arm. By means of two screws, on the side of the spring controlling the index finger, it may be adjusted and brought to zero; and there is adjustment for wear of the points of the pins upon which the finger swings.

A gauge for use in assembling the parts of a steam engine consists of an adjustable head or head caliper having a central pinion, which drives a rack in each direction equally. Through the opening the aligning cord passes, and rotation of the pinion causes the ends of the caliper to adjust themselves to cylinders of any diameter within the capacity of the device.

Tests made by G. W. Bissell of Ithaca, at Sibley College, go to show that at low rates of feed the effect of pressure on the coefficient of friction is practically *nil;* which would tend to prove that under such conditions lubricated rubbing surfaces follow the loss of solid or "immediate" friction; but at the rate at which this state of affairs begins to be apparent, the augmentation of the coefficient is dangerous to the continuance of the smooth running of the journal. It is unsafe to reduce the rate of feed below .003 cubic centimeter per square inch of projected area of journal per minute.

C. V. Boys has discovered that a millimeter screw may be cut with a one-eighth inch leading screw, by the following change gear wheels: 28 on mandrel, 100 and 36 on stud, and 32 on screw. The error, with a perfect lathe, would be less than one in 9000.

Copper gaskets of U section, opening outward and filled inside with asbestos, are now on the market in Germany. This arrangement protects the abestos from moisture.

HYDRAULIC FORGING PRESS.

In a hydraulic forging press made by Galloways the force pump and the main cylinder of the press are in constant communication, without any valves between ; nor has the pump any clack valves, but it simply forces its cylinderful of water directly into the cylinder of the press, and receives the same water back on the return stroke ; the large ram of the press rising and falling in time with the strokes of the pump, keeping up a continuous oscillating motion ; the ram of course traveling a distance which is shorter than the stroke of the pump, in inverse proportion to the areas of the cylinders. The ram may be lowered or raised at any time by a special hydraulic connection.

HYDRAULIC FORGED RAILWAY WHEEL CENTERS.

A new method of making wrought iron railway wheel centers is by drop-forging them from parts first rough shaped, which are not only die-forged but welded together. The parts are (1) a cylindrical band, which forms the rim of the wheel, (2) a triangular bent piece having a convex inner surface, the curved side forming part of the rim, and each straight side forming half a spoke, (3) hub pieces having radial grooves, into which the inner ends of the spokes are placed. These wheels are of the Vauclain type, and are made by the Baldwin Locomotive Works.

The set of coiled wire may be done away with by drawing it to a considerable distance from the die before coiling.

Cast iron cutting tools, which have been used for twenty years in the Pennsylvania Railroad shops, are now being introduced into others. They are superior to steel ones for roughing, but cannot be used for finishing, as they will not hold a fine edge, particularly if the work is discontinuous, as the edges of the teeth of a spur wheel.

WOODWORKING MACHINERY.

In few lines of mechanical performance have American mechanics such marked and such deserved pre-eminence as in the design, construction, and operation of woodworking machinery. The vast quantity of constructive and ornamental timber with which Nature has favored us, and the necessity, in a comparatively new country, of building with and working in wood rather than in stone and metal, have given to the design and manufacture of woodworking machinery an impetus which has readily enabled us to get and so keep the lead.

CUTTING LUMBER WITHOUT SAWS.

A new lumber-cutting machine invented by Dr. Bradley, of New York, is 42 feet long, 15 feet wide, and 8 feet high, weighing 45 tons. Its object is to save time and lumber. It is claimed that it will take a log eight feet long and cut boards from it at the rate of

forty a minute, of any width from $\frac{1}{32}$ of an inch to one inch in thickness, without kerf.

The knife is three feet long and weighs 500 pounds. It works with a draw motion to prevent the fibers of wood from breaking. A roller, preceding the knife, compresses the wood and aids in this matter, which the inventors found was the most difficult of the ends to be attained. The knife is moved by a wooden connecting rod fastened to a wheel ten feet in diameter. Every revolution of this wheel makes a board.

The total output of the machine, when in running order, is stated at 80,000 to 100,000 feet a day.

GANG GAINER AND GROOVER.

A horizontal gang gaining or grooving machine, made by the Bentel & Margedant Co., and brought out just before this work goes to press, is intended for cutting a number of grooves or gains in material at once. There is a long horizontal mandrel, bearing a number of heads, which are adjustable in their distance apart. The material is clamped and held securely on the table, which moves across the machine under the cutter heads. It has both power and hand feed. Its use is specially appropriate for making filing cases, desks, and similar work. It takes in work up to eight feet two inches long and 24 inches wide.

MOLDING MACHINES.

An extra heavy twelve inch standard molder, brought out by the Egan Co., is claimed to equal in capacity any inside molder yet made, while possessing all the advantages of the outside molder in setting

up. The outside bearing goes clear down to the floor, and is braced by a solid projection from the base of the frame. It is not necessary to remove any bolts or outside boxes in order to raise and lower the bed. The side heads, with their spindles, raise and lower with the table, and both the inside and the outside spindles are adjustable both vertically and horizontally, while in operation, by hand wheels on the front side below the bed. The under head is also adjustable laterally. Each head has its own chip breaker. The bonnet is adjustable to or from the head, independent of the adjustable shoe, which can be brought clear under the knife. The bonnet saddles on a stud, and can be swung clear out of the way, giving free access to the knives. The pressure foot for the lower head is a cored arm, projecting from the back of the frame and supported at the front of the bed. The feed consists of four rollers, two on the bed and two above, all driven by gearing, and there is expansion for driving the lower rollers. There are two feeds on every machine. The upper feed spindles are hung on links so that the feed rollers raise up parallel, giving the feed rollers a full bearing on the board the entire width of the piece. The system of weighting permits the feed rollers to be raised up instantly, and the board may then be slipped back.

In a new nine-inch four-sided molder, brought out during 1891, the table, together with the side heads and the lower head, is raised and lowered by a large hand wheel in front; the lower head has both independent vertical and lateral adjustment, as have the side heads, which can also be set beveling, if desired.

By this plan of having the side heads raised and lowered, raising and lowering the table does not interfere with the cut of the heads. The feed consists of four driven rolls, two above and two in the table, and all geared. The table can be dropped 16 inches. The upper feed rolls are hung on trunnions and raised and lowered parallel. The pressure on either the front or the back roll can be increased or diminished at the will of the operator.

SANDPAPERING MACHINES.

A triple-drum sandpapering machine is for sandpapering planed surfaces for furniture, pianos, etc., where the work is to be varnished or painted. There are three drums, made of steel, and on which the sandpaper is placed, its grade being according to the work to be done. The first drum carries coarse paper, the second a fine grade for smoothing, and the third a finer grade for polishing. Each of these drums has a lateral oscillation across the material to prevent the formation of lengthwise scores, which would be the case if the material moved straight and the rolls had no such endwise vibration. The feed rolls are eight in number, four above and four below the platen, and are driven by a train of expansion gearing. They are so placed that the material will pass between the upper and lower sets, and open to receive material eight inches thick. The lower rollers are placed one each side of the drum, each roller being in a separate bedplate, which is adjustable with the roller, and the roller has a separate adjustment from the bedplate. Each bedplate can be set to gauge the amount of cut to each drum, or all the bedplates

can be set in line and the drums set to the cut desired above this line. The upper rollers are mounted in a frame over the corresponding lower rollers. The pressure rolls are three in number, one over each drum to hold the material firmly to them, and are separately adjustable by hand wheels in front, which operate worms and worm gears. The feed is governed by a double belt tightener operated by a hand lever, by which it may be instantly started or stopped. The drums may be removed by raising the entire roller and bed frame, which opens a space directly over them sufficiently to lift them out and over their bearings. This raising device is operated by a hand wheel by which the screws at the four corners of the machine are turned, the screws resting on friction rollers, giving very easy motion in raising to any height. The adjustment of the drums for the difference in heavier or lighter cutting is done by the movement of three hand wheels at the end of the machine.

A new sand belt machine has two pulleys on horizontal axes, bearing a sand belt across which the spoke or other similar article to be sanded is laid in a frame between a live and a dead center, the frame having a swinging motion to bring the spoke upon the belt with any desired force, and also a swiveling motion to present it at any desired angle with the belt. In addition to this, a crank permits rotating the spoke on the centers.

NEW MORTISERS AND TENONERS.

An automatic square-chisel car mortiser and tenoner will not only cut heavy mortises, but make end tenons, gain or mortise clear through a timber nine inches thick, and countersink for bolt heads. The frame consists of a casting, cored out at the center and bearing at one end a knee in which the square chisel-bar plays, and on its top, at the opposite end from the knee just mentioned, a table having an upright bracket, against which the side of the timber to be mortised bears. A clamp piece on this bracket holds the timber down. There is a dead roll in the table, for facilitating feeding the timber endwise across the machine. By a hand wheel the mortising bar is raised or lowered to suit any point on the width of the timber; by a screw and hand wheel the mortising bar is brought up to the timber and the square chisel forced through; a hand lever performing for the auger the same function. The cross movement of the bed is controlled by a friction clutch having steps to gauge the length of the mortise. The chisel mandrel is driven by a friction gearing with a quick return; and there are suitable stops for gauging the travel of the slide; also a regulating screw for changing the position of the chisel to suit the work. An extra boring attachment is fitted to the machine for boring joint-bolt holes, side and general work.

The Egan Co. has brought out a tenoning machine, which will make tenons on both ends of a stick at once. Besides this feature the new machine, instead of making the tenons by the cutter heads,

rather too long, and then cutting them off to the desired length, thus leaving a bur or ridge, first cuts the stick to the proper length and then makes and finishes the tenons, leaving the latter with a smooth end finish.

SAWING MACHINERY AND APPLIANCES.

Arbey, of Paris, has greatly developed his tree-felling machine and his forest log cross-cutting machine. In the former there is a steam cylinder bearing upon its piston a drag saw, and having a swiveling motion which causes the feed. Suitable contrivances are given to permit the machine to be fastened to the trunk to be sawed.

A double rip and cross-cut sawing machine for edging, ripping, and cross-cutting, particularly for pattern-makers, has a column in one casting, and there are two saws, one for cross-cutting and the other for ripping, borne on a frame rotating about a center within this column so that either can be brought through the throat of the table, and either one may be projected through any desired distance for grooving. The table is in two sections, the one to the left of the saw working back and forth on rollers, for edging and cross-cutting. The machine is supplied with two miter fences for cutting right and left, and one ripping fence. A boxing prevents the saw that is being thrown out of place from injuring the operator while in transit. The table tilts at any desired angle to the plane of the saws, and the fences have suitable circular graduations for mitering and beveling.

The Egan Co. has made a band re-sawing machine

which will saw a $2\frac{1}{8}$-inch plank into two one-inch boards at one cut, thus effecting considerable saving in lumber.

A saw mill dog brought out by the Knight Mfg. Co., of Canton, O., belongs to that class in which an adjustable head carries the dog bit, and is secured at any point on a horizontal sliding bar, with a lever connection to force it into the timber. The upright is formed of two parallel straight pieces, in one of which the head carrying the upper dog bit slides, giving adjustability in height; the locking mechanism for this being by an eccentric and lever. The lower dog is inclined at an angle of about 45 degrees with the vertical, its lower end being turned up to about the same angle. It is controlled by the lever which operated the upper dog. The lower dog bit moves upward until it strikes the timber, then upward into it, both dogs being locked in position when first in the timber. To operate the upper dog, the dog bit is dropped on the log and is forced downward into the timber by drawing downward upon the long lever. When released from its bite in the timber, the lower dog returns to its original position, automatically locking itself, and remains there out of the way until again liberated by the operator.

These dogs are made right and left handed. For a right-hand mill a right-hand dog is used on the front head block and a left-hand one on each rear block; while for a left-hand mill a left-hand dog is used on a front head block and a right-hand on the rear.

LATHES.

An automatic spoke lathe, brought out by the Egan Co. in 1891, combines the principal features of the Blanchard lathe with new ones. The bed or frame is wider than is usual, and the "V" is placed some distance back of the center line of the cutter head, allowing the belt to press the front of the carriage down to the "V" as it travels along. The construction of the bed is such that chips are not liable to accumulate on the top to obstruct the rollers. There is a sliding carriage, having four rollers with their journals held in position by collars on the outside; the carriage has adjustable gibs to the main frame, to prevent side play. The standards carrying the cutter head are bolted to the carriage on planed surfaces. The head has a combination of hook and gouge knives. The vibrating frame is cast hollow, and is connected at the top by hydraulic pipes, to give strength and lightness. There are adjustable trunnion boxes to change the size of the spoke. The gearing is cut from the solid, and the center gear has double width of face, to permit the operator to change the shape of the spoke. The back center gearing is so constructed that various lengths of spoke may be turned from one pattern. The eccentric center is very large, requiring no ratchet to keep the spoke in position while being turned. The spring pressure bar has three cast steel coil springs connected to the carriage with a slide, working in planed ways, operated by a hand wheel and screw, so as to permit wide range in size of spokes that may be turned on it. The feed mechanism will ordinarily change the

rate of feed at the start, although, by a slight change, it may be made to give the same speed all along. By pressing a lever the feed may be stopped in any desired position along the spoke for setting the rests or truing the knives.

An improvement recently added is for automatically lifting into the cut the frame carrying the spoke, so that all the operator has to do is to remove the finished spoke and put in the stick for a new one, —not even leaving his position, but merely pulling a lever, which sets the vibrating frame into the cut; then the carriage, with the cutter heads attached, travels along the bed, completing the spoke; the vibrating frame throws forward, and the carriage and head return to the starting-point to cut another spoke. This is of course much more convenient than lifting the frame into the cut every time a spoke is turned.

This lathe has a record made in a spoke factory in Mississippi of 2695 spokes per day of 10 hours, which is claimed to be the greatest record ever made on a spoke lathe. The average capacity of the new lathe is claimed to be 2200 to 2400 spokes per day, more than double the ordinary capacity of such machines.

The latest automatic spoke-turning and squaring lathe, made by the Defiance Machine Works, is for turning all kinds of spokes up to 30 inches long and 4½ inches in diameter. The cutter heads are large, and fastened to a spindle by friction grip only, to do away with marring the spindle by set screws. The knives, of which there are three to each head, are flat and shear cutting, their edges ground straight over. Hinged to the back of the frame there is a

shield, surrounding the heads and preventing injury to the operator, besides discharging dust and shavings at the back of the machine. The table is of two parts, coupled together, at the tail center end, by a steel pin in one of several holes which extend through both tables. The lower part, which rests upon the frame, slides upon gibbed angle ways, and is operated to and from the cutter heads by a hand lever. A forming cam rotates against an upright shoe attached to the lower table, and vibrates the upper table according to the cam shape which governs the spoke section. If the pin which connects the two tables is opposite the tail center the tread end of the spoke will be round, gradually changing to oval at the throat, where it will agree with the cam section. If the pin is placed toward the right-hand end of the table the oblong shape at the tread end will be more marked. Sharp-edged spokes are turned with an attachment, or extended table, carrying the center line of oscillation at a sufficient distance to turn both the throat and the tread alike; forming two straight lines on the sharp edge. The tail block has adjustments for spoke length and taper. Rived and sawed timber is used in this lathe and finished at one operation. The capacity for turning and squaring is two hundred and fifty complete spokes per hour, ready for polishing.

The new automatic spoke and handle lathe made by the Defiance Machine Works is for turning and squaring wagon and carriage spokes, although it has adjustments for turning common, Sarven, or sharp-edged shapes, making either light hickory spokes or

heavy ones for wagon, truck, or artillery wheels, up to forty-four inches long and five inches diameter. There is a rotating horizontal cylinder composed of rotating knife cutter heads placed side by side to make up the length of the spoke; each head having three cutters of three inches face, lapping over each other so as to form a continuous cutting edge over the entire length of the cylinder. There is a table in two parts, gibbed and sliding on the frame in angular ways, being moved to and from the cutter by either a hand or a foot lever. The upper part of this table supports the turning centers, and is pivoted to the lower half, near the tail center, by a steel pivot, in one of several holes in the table, on which it vibrates for oval turning. At the opposite end of the head center spindle is a cast iron cam of the shape that it is desired to turn; this cam riding against an upright shoe extending up from the lower table, and held snug against the shoe by a coiled spring. When the table is moved toward the cylinder to where the turning is begun, an automatic feed slowly rotates the object to be shaped, and the cam, rotating against the shoe, oscillates the table in a path corresponding with the shape of the cam. When the pivot is placed directly opposite the tail center, the machine will turn the work round at the tail end, gradually changing in section toward the other end, where it will correspond with the shape of the cam. For long, oval, or irregular turning, where both ends must correspond in section with the cam, the vibrating part of the table is locked fast with the lower part, and the cam rotates against a shoe fastened to the frame, thus vibrating both tables alike at each end. The

diameter of turning is regulated by screws. The tail center can be adjusted at any desired distance from the spur center for short or long turning, or at right angles for straight or taper turning. The swinging cutter head is made to advance and retreat from the work automatically, its position being regulated by the movement of the table, the section turned being governed by a cam upon the live center table. It will turn square, octagonal, or any other section desired.

CARVING AND ROUTING MACHINES.

A geometrical carving and corner block machine, patented by S. Y. Kittle, seems to be a valuable adjunct to an ornamental wood shop, and useful in making interior wood decorations for ceilings, such as corner pieces, center pieces, borders, etc. There is a frame which has a square table or box with a flaring base and a continuation having a gap somewhat in the manner of a band saw or drill press frame ; this carries the vertical router spindle, the pulley of which has one bearing above and one below, the belt passing over two idler pulleys at the back of the frame and down over the main pulley which is at the bottom of the machine, at the back ; the shaft running fore and aft, and hence at right angles to the router pulley shaft and the idler shaft. The table has vertical motion by a rack and pinion, and horizontal adjustment, as well as tipping motion for certain classes of work. There are adjustable stops to regulate the depth of cut ; and the table has an index for dividing and regulating its circular movement. There are suitable clamps and jaws for centering and holding down the

blocks, and the whole table is counterbalanced so as to move more readily up and down by a hand lever. The router shaft pulley is covered by a casing which protects the operator and keeps oil from being slung over him and the work. By this machine, work of the class done in metal by a rose engine or geometrical lathe may be effected; and by an attachment the operator can cut designs on material of any length as in the case of long boards on mantelpieces. Another attachment is for routing or duplicating operations in line for fancy moldings, consisting of a table, with rack and pinion feed, that may be fed along by a hand wheel or by a lever and ratchet, as desired.

PLANERS AND SURFACERS.

In a 26-inch double surfacing machine, brought out by Rogers & Co., the cylinders are large and slotted, and run in yoke boxes. There is a bonnet chip breaker and a complete set of pressure bars which have every desirable adjustment. The lower cylinder may be set for any desired cut, and the end of the bed will swing down to admit of easy access to the head for sharpening or setting the knives. The bed is raised and lowered on four screws by hand or by power; and when power is used an adjustment of eight inches is accomplished in one minute. When set to proper thickness the lower cylinder, while firmly clamped to the bed, is also clamped to the sides of the frame. The gears on the feed rollers are of about double the diameter of the latter, giving great leverage. Each pair of feed roll boxes is connected in a yoke frame to avoid the possibility of cramping, and all links are hung on boxes instead of

on roll shafts. The feed is driven direct from the top cylinder through two feed shafts, provided with cones giving four changes of speed.

Rogers & Co. have brought out during 1891 a fast feed planer and matcher, to work 15 inches wide and six inches thick, feeding from 25 to 100 feet per minute.

UNIVERSAL WOODWORKER.

An extra large universal woodworker, brought out by the Egan Co., is for dressing and taking out of twist large timbers and planing them perfectly true to a right angle at one operation. The main head, on a horizontal axis, is slotted on all four sides. There are tables of unusual width and length, and having wide grooves by which to fasten the gaining and paneling frames exactly at right angles to the cutter heads. Either table may be raised and lowered independently of the other, or they can be raised and lowered together in a circular manner concentric with the head, or they may be raised and lowered together vertically. All the adjustments are made from the working side of the machine close to the cutter head, permitting the operator to make the desired adjustments without going to the end of the machine. The front bearing is adjustable and may be taken off when a change of heads is desired. The bearings of the mandrel are such that the boxes with the mandrel and head may be moved back and forth across the bed as desired, instead of making the adjustment by means of the fence. The beveling fences adjust across the table. One of them is placed over the

main head and the other back of the upright head; both have sliding plates and, when beveling, the lower part is close to the table and has no forward motion.

The bearing attachment, on the opposite side of the machine from the main head, is independent of the latter, so that two men may work the machine at the same time without interference.

A new pedestal shaper, made by Rogers, has some very desirable features as a variety molder. There is a solid pedestal frame, having each side of it a column or post extending from the base to the table of the machine. The yoke boxes are supported by six posts and by the pedestal, so that the spindles are perfectly aligned. The yokes and their spindles are raised and lowered by hand wheels in front, and may be dropped below the line of the table.

WHEEL MAKING MACHINERY.

In no lines of woodworking machinery has American ingenuity responded more effectually to the demands of manufacturers than in producing machines for practical everyday operation in making vehicle wheels of the excellent woods with which Nature has endowed us. There is scarcely a single operation—if indeed there be one—in the manufacture of wagon or carriage wheels from the rough wood, that is not done by machinery, most of it, too, power; driven and automatic; and the products of these machines as far excel in their strength and finish the crude productions of Old World wheelwrights, as

American hickory does the inferior woods with which the latter are compelled to serve themselves.

The Defiance Machine Works have brought out a double automatic rim strip equalizing machine for cutting off the ends of rim strips preparatory to entering the bending machine. As a number of pieces of this class are bent at once, it is desirable that their lengths should agree in order that each shall have an equal bearing on the heel casting attached to the bender strap, this greatly reducing the liability of breakage while bending. There is a table eight feet long and twelve inches wide, capable of holding a number of rim strips at once. Running lengthwise of the table there is an adjustable gauge for regulating the length of cut. The table slides upon ways which are planed true and have gibs. The saw is circular, 16 inches in diameter, and running 2400 turns per minute.

A new rim and felloe rounding machine made by the Defiance Machine Works is for rounding and finishing the inner ends of rims and felloes after they are bent and bored for the spokes. There is a single vertical columnar stand, at the top of which there is a rotating cutter between two guiding disks, between which the rim or felloe passes. The cutter heads are adjustable for felloes of different widths, and are supplied with eight cupped shear-cutting knives with semicircular edges. A stationary guide rest between the heads regulates the depth of cut, and a gauge pin upon the periphery of the rest spaces the distance from the spoke hole at which the rounding shall begin,

This pin can be set to round as closely to the tenon hole as desired. The rim or felloe is placed between the guides, with the gauge pin in one of the spoke holes, and is then brought down upon the cutters and moved toward the next spoke hole, rounding one-half of the rim between the holes. The pin is then placed in the next hole, and the process repeated until one half of each space between the spoke holes is rounded. The rim is then reversed and completed by a like operation. The circular guides, which support the felloes sidewise, are adjustable for different felloe widths and for holding centrally with the heads the material to be rounded.

A rim packing and cutting off machine, made by the Defiance Machine Works, is used by makers of bent rims for wagon and carriage wheels. After the rims are bent they are placed in a sliding carriage between centering jaws and packed together to a uniform circle, making them all register alike, and then in this position the carriage is moved by the saw and a small surplus cut from both ends of each rim ; a strip is then nailed across to the ends of the rims, when the package is prepared for shipment. The traveling carriage is mounted upon three friction rollers, which run upon T-rails. The jaws for holding the rims are fitted to the carriage in planed angle ways; their faces are also planed true and square with the carriage. The two jaws standing opposite each other are worked at the same time by a hand wheel. The center jaw has an independent adjustment and acts simply as a gauge. The jaws open and close sufficiently to take in rims from 24 to 60 inches in

diameter, and receive enough to make a stack nine inches high.

A new automatic hub turning and finishing machine is for the purpose of turning plain, beaded, banded Sarven and Warren hubs complete, with unskilled labor. The rough hub block is placed in the machine, which first roughs it down to the proper size by a roughing knife having a straight face 12 inches long, and which is fastened to a stand at the back end of the sliding carriage, with its cutting edge extending downward, taking off at one cut a ribbon one-eighth inch thick of the full length of the hub; a gauge limiting the depth of cut. By a reverse movement of the hand wheel the roughing movement retreats and the finishing knives come into play; the diameter to which they turn being regulated by screws attached to the carriage so that once adjusted the machine turns out hubs of only one finished diameter. The finishing knives are at the opposite side of the carriage from the roughing, and their cutting edges extend upward. At each end, upon the same stand as the finishing knives, are the knives for cutting band seats; on separate stands, the knives for finishing the ends, these last being in advance of the body and band knives. A single set of knives will turn and finish hubs of the same shape to any diameter within the machine's capacity. The feed is by friction.

An automatic wheel boxing machine, recently produced, is for holding and boring a light vehicle wheel. There is a cylindrical plunger having a conical interior, and worked by a spring, which receives the point of

the hub, and centers it truly ; the rim of the wheel is fastened in a true plane by resting against the arms of the face plate of the machine ; and two rotating padded disks, embracing the spokes near the hub, hold the wheel firmly in the desired position. The contour of the axle box, to which the wheel is bored, is filled by an automatic device. Provision is made for cutting both ends of the hub to any desired shape or size. The feed is automatic, and is stopped at the end of the cut by an automatic stop. The outer rotating binding pad, by which the wheel is held, has 40 steel balls, five-eighths of an inch in diameter, to lessen friction. The inner pad is adjustable to suit the varying dish of wheels. The wheel turns 200 times per minute, and the cutter 5000.

The latest automatic spoke driving machine holds the hubs at each end in a pair of adjustable saddles having vertical adjustment for the length of spoke, and horizontal adjustment for length of hub. The hammer is supported by a power shaft driven by a clutch, composed of a friction disk keyed to the shaft and a loose friction driver, each having double friction faces that correspond. The driver has lateral motion, and is connected by a foot lever for controlling its position with relation to the disk. A spring automatically separates the frictions, the driver acting as a loose pulley when disengaged. When the operator's foot is placed upon the pedal the frictions are engaged and start the hammer, which delivers a blow similar to that of one swung by hand. The force of the blow is regulated by the pressure upon the pedal, as is also the speed of the blows. There is an

adjustable gauge for guiding the spoke into exact position.

A recent automatic skein setting and fitting machine is for dressing the ends of wheel axles to proper shape to receive the skeins. With unskilled labor it dresses 200 axles per day of ten hours, and fits skeins from 2⅜ to five inches, of either cast iron or steel. The skein and axle are put into the machine, and a carriage carrying a cutter is moved backward with an arm carrying a friction roll on the inside of the skein. When the friction clutch is engaged, the cutter bar rotates and feeds into the cut. The friction roll follows the exact shape of the skein and governs the path of the cutter, turning the end of the axle to an exact duplicate of any skein placed in the machine. When the end of the cut is reached, the friction roll leaves the mouth of the skein, and the cutter is lifted from the cut, out of the way.

The friction roll traverses the inner circle of the skein to be fitted, and the cutter bar is at the opposite end of a double arm which bears this friction roll. A heavy spindle, through the center of the bar, connects it to a circular sleeve, rotating in heavy bearings mounted upon a sliding carriage, which is fitted into angular ways and provided with gibs, and has a horizontal adjustment by hand wheel to carry the cutter to and from its work.

TEXTILE MACHINERY.

AMERICA is gradually increasing its lead in several departments of textile industry and gaining place in others. Her mechanics are ingenious, and her manufacturers and merchants enterprising, while her rapidly-increasing wealth and civilization make it possible for textile industries to progress at a rate which offers ample reward to the ingenious and wide awake. There are, however, no startling inventions or discoveries to be recorded as belonging to 1891, either not completed or in completion; but all along the line there has been steady advancement which, it is to be hoped, will find a parallel during 1892.

EVENING DEVICE FOR YARN RACKS.

A new dressing rack, for giving yarns even tension at all times in the process of running them from the spool, has a pedal or brake bearing upon the surface of the yarn and the spool, and held there by a spiral spring. As the diameter of the roll of yarn upon the spool gets less, the leverage is of course changed and the tension is kept practically even, thus preventing "section stripes." It is claimed for this device also that spools with crooked arbors will run as well on them as straight ones, and that the spool heads cannot strike or rub on the framework of the rack. Short and long spools may be used at will, there being an extension at one side to take in the long ends. To prevent the threads from the long spools interfering with each other or with those from the short ones, they run over a light pine roller one and a

half inches in diameter, the friction of the yarn turning the rolls as it passes over them, the thread traveling in its own place from the spool.

BOBBIN WINDING.

Textile manufacturers are interested in an improved arrangement for rendering winding machines more effective. In this mechanism, mounted upon the same axle as the bobbin cradle, is a lever to which is pivoted the upper end of a vertically-sliding brake lever, normally held in its position by a sliding rod, through an aperture in which pass the detector wires; the bobbins are normally pressed against the drum by a weighted cord attached to a bobbin cradle, passing beneath a pulley on the brake lever and over a pulley on the frame. When a thread breaks, the wiper engages with the fallen detector wire, and the catch bar is slid horizontally, releasing a cord which is then forced upward by a weighted cord; this causes the brake block to take against the bobbin and raise the same from the driving drum, the bar being at the same time moved farther on the left by means of an incline, thus moving the fallen detector wire out of engagement with the wiper. The parts may be brought back to their original position by means of a handle which is pivoted on a lever, and is provided with a fork for engaging with a pivot pin; and it is also provided with a catch for engaging with a part of the bobbin cradle, in order to hold the latter in the raised position, when it is required to find a broken end, etc. To have the detector wires stronger than usual, they are suspended from balanced levers.

STOP MOTION FOR CARDING ENGINES.

An ingenious kind of stop motion for carding engines is being introduced. In this arrangement the shaft of the upper calender roller is prolonged for a short distance beyond its bearing, and a worm affixed to the end gears into a worm wheel mounted on a stud attached to a bracket on the framing; the wheel also having affixed to its face a pin which engages with a lever, the latter in turn acting upon one end of another lever. The other end of this last-named lever is bent in such a manner as to pass under a catch pivoted to one side of the doffer lever, the latter being supported in working position by the catch. On being passed through the calender rolls at the proper thickness, the worm on the upper calender shaft is held out of contact with the worm wheel: on the other hand, when it becomes too thin or is entirely absent, the worm falls into gear and rotates the worm wheel, thus moving the levers about their centers, releasing the catch attached to the doffer lever, and stopping the engine.

John Bromley & Sons, of Philadelphia, have undertaken to manufacture lace curtains in this country, at the rate of 5000 pairs per week.

THE TRANSMISSION OF POWER.

Each year man seems more and more averse to doing anything by hand power that can possibly be done by employing the forces of Nature. This reluctance to physical exertion, while a reversion to the time of the savage, brings with it in its train a degree of ease to both sexes, and an immunity from danger and disease, of which the savage, not in love with muscular exertion, knew nothing. In these days of engineering skill, if the mountain will not go to Mahomet, the latter, instead of going to the mountain, sees that the mountain (or so much thereof as he wishes) comes to him. If there be a waterfall, the power of which the modern Mahomet thinks would be serviceable to him, to grind his corn, or to elevate Mahomet himself to the upper stories of his residence, the ingenious compeller of Nature's forces gives orders that the power be saddled, bridled, and driven to his door. It may be by wire, or manilla ropes, or by compressed air; by water under pressure, or by the mysterious electric current, that the power is brought from one place to another ; the conditions determine which will be the most valuable; but the power must be brought to where it is available for use, instead of the place of application being planted at the side of the power.

One of the most noteworthy advances in the transmission of power for short distances, is that by ordinary cotton and manilla ropes, the system lending itself particularly well to installments where the direction of transmission is tortuous, or in very suddenly

varied directions; but this, being now a very fairly established practice, can receive no more than mere mention at the hands of a chronicler of the doings of 1891.

The most important project for the transmission of power for any great distance is that for carrying 125,000 horse power from Niagara Falls to power-users in the district within from ten to fifty miles of that source of power. This will be found treated under the head of Hydraulic Engineering, because the skill, time, and capital required are called for more by the development of the power than by its transmission—the latter being merely an extension of principles and constructions now familiar.

Birmingham, England, has a high pressure hydraulic plant for supplying the elevators, etc., in the city with water under pressure. At present there are but eighty hydraulic elevators in the city. The water is to be delivered at 430 pounds pressure into two six-inch hydraulic mains, which are connected by two accumulators of cast iron, with cast iron rams 18 inches in diameter, loaded with 84 gross tons. The saving in water is estimated at the difference between 7000 and 70,000 gallons per year, and the cost of running a "lift" will be reduced from £25 per year to £9.

Compressed air is furnished power-users and others, in Paris, from a station started in 1889, and now supplemented by one on the Quai de la Gare, laid out for generating 24,000 horse power, of which 8000 horse power is expected to be used in 1891, and 18,000 in

1892. The coal consumption is kept down to 1.54 pounds per horse power per hour, by a penalty of 2000 francs for every hundred grams in excess of this limit. The air is compressed to 30 pounds per square inch, then passing into a receiver it is cooled ; then it is let into a final compressing cylinder, and raised to the pressure at which it passes into the mains, 90 pounds per square inch. The actual engine duty per horse power per hour is 384 cubic feet of air at atmospheric pressure. The compressed air valves are seven inches in diameter, and are brought back sharply to their seats, at each stroke, by a small piston operated by compressed air flowing through a bypass from the chamber. The mains are 19.69 inches in diameter, made of riveted steel plates. The velocity of the air has been brought up to 49 feet per second ; but the actual speed used every day is about 19 feet eight inches per second. This gives a loss of 0.07 atmosphere per kilometer.

Luzerne, Switzerland, is to have pneumatic transmission of power from waterfalls, and Offenbach is to have a similar distribution. The pipes are 7760 yards long, and from twelve inches down to four in diameter. The power is 500 horse, and the loss in transmission 13 per cent.

As within the city of Dresden the erection of steam boilers is prohibited, compressed air is proposed for power distribution there.

It has been figured out that of 5000 horse power generated at Niagara 3000 could be used at Chicago.

INDUSTRIAL TECHNOLOGY.

THE skill of the chemist is called for in almost every walk of life in which progress is desired to be made, or in which it is feared that there is danger of being left behind. Materials that have been considered valueless, except for almost unprofitable purposes, have been shown by him to be well worth working by improved processes; and others which have been looked upon as so much more weighty matter, good perhaps only for ballast in case they were hard and heavy, have yielded to the magic persuasion of his art, and become articles of commerce and sources of contention by those who wish to control their output or utilization.

CONTINUOUS ACTION RETORTS.

The Mechanical Retorts Company, Limited, of Paisley, Scotland, has produced a retort with continuous feed and discharge. In this the charge is kept as free as possible from contact with the shell, and is spread out to receive the heat radiated down upon it from every side. The gases liberated are forced to travel in a certain direction, which keeps them as much as possible from the shell, while traversing the interstices of the material. The products are generated at the upper surface of the charge.

The retort consists of a vertical cylinder about eight feet in diameter at the bottom, increasing by three-inch intervals until it is nine feet wide and seven feet high. Both top and bottom are closed by

disks, each having a large hole at the center. Projecting upward from the top disk, and downward from the bottom one, are sleeves which pass through the flues and brickwork to the open air, and which are fitted at their extreme ends with stuffing glands, in which turns the center shaft, driven from below by gearing. The sleeves are much larger than is necessary for the shaft. Through the upper one the material to be distilled is charged, the products being removed by the lower one. The center shaft is stepped, but diminishes in diameter toward the upper end. The steps on them are at different intervals from those on the shell, so that the disks which rest on them do not rest on the shell, and *vice versa*. The disks on the shaft are smaller by about a foot than the shell diameter, and those on the shell have a large hole in their center, leaving a narrower passage around the shaft. From the under side of each plate are hung scrapers or duplicators, acting like plows; all of them scrape the material outward on the shaft disks, inward on the shell disks. Thus the material is gradually worked down to the bottom, by an intermittent motion. The heat is applied by a gas producer, or by a furnace, and is applied at the top of the retort; then by a zigzag course on each side of the retort to the bottom. The cold material is introduced where the fire is the hottest.

With $2\frac{3}{4}$ cwt. of coal per ton of wood, the retort puts through 12 tons of birch shavings per 24 hours.

REDUCTION OF REFRACTORY ORES.

In Shedlock's apparatus for the treatment of refractory ores the stone is crushed in the usual way, and subjected to the action of gases under pressure, whereby the whole of the sulphur, and other materials which render the ore refractory, are separated. The ore is then conveyed into a vessel containing an absorbing fluid metal, so constructed that every part of the ore is brought into contact with the metal. For the production of reducing gases, steam and air are passed through highly heated materials having an affinity for oxygen, and the gases so produced are utilized for raising the ore to a high temperature. The tailings passing off are said to be worthless.

A process of coating iron with lead or zinc has been shown in Millwall, London. The iron articles are first pickled in acid, then dipped in lime, then in clear water ; then dipped in a liquid bath of zinc and tin in equal parts, in hydrochloric acid ; then through a bath of molten lead.

NEW INDUSTRIAL PROCESSES.

The commercial manufacture of ozone has been undertaken by a company in the city of New York, by the Siemens process.

A recent improvement in the manufacture of chlorine gas and caustic soda, by electricity, uses a vessel of iron or of carbon, which, in the latter case, is jacketed with copper, and forms the cathode. The anode is a

porous diaphragm consisting of a number of V-shaped porcelain troughs, built up inside of each other; the spaces between them being packed with asbestos, or with powdered soapstone. The raw material is brine, which is supplied from separate tanks to the anode, and, following along the series through the cells, is eventually returned to the tanks. The chlorine escapes from the electrolyzing vessel through an outlet pipe in a porcelain cover.

The manufacture of iron sulphate in quantity, and cheaply, renders its use valuable in the purification of water on a large scale. P. & A. Buisine have obtained it from the residuary burnt pyrites from chemical works, by mixing with sulphuric acid and stirring while at a temperature of 100° to 150° C.; then adding water to get a strong solution; then adding more acid, and so on until the pyrites are entirely decomposed. The water purified by it is clear, colorless, odorless, neutral, or very slightly acid; while that done by lime is alkaline, colored, smells, and retains organic matter in solution. Furthermore, by treatment with carbon bisulphide, the grease contained in the water may be recovered from the precipitate.

A new white lead process by MacIvor, is something the same in principle as the ammonia-soda process. A solution of ammonium acetate is allowed to react on litharge, with the production of a basic lead acetate. The liquid or semi-liquid mass of white color thus produced is agitated, and carbonic acid gas passed through it in the cold, forming basic lead carbonate, or

white lead, and reproducing ammonium acetate, which is used over again to dissolve a second charge of lead oxide.

A new method of refining camphor is now practiced in Japan, the machinery having been made at Pittsburgh under the Symes patent, and having a capacity of 50,000 to 75,000 pounds of refined camphor per month.

ARTIFICIAL COLD.

The cryogene is an apparatus designed by Cailletet for producing a temperature of from 90° to 110° below zero F., by the expansion of liquid carbonic acid. There are two concentric vessels with a small annular space between them ; a spiral coil is placed inside the inner vessel and put in connection with a closed vessel containing liquefied carbonic acid gas. At its lower end the coil is connected with the annular space, and at its upper a stop cock is fitted. The inner vessel being filled with alcohol, the stop cock on the carbonic acid vessel fully opened, and the stop cock on the spiral partly opened the liquid passes slowly into the coil and takes the form of snow. From the coil it passes into the annular chamber, in which are pieces of sponge soaked in alcohol, which arrest all acid that has not become gaseous, while the gas itself passes out of the apparatus through a bent tube. With 5½ pints of alcohol in the inner vessel and 4½ to 5½ pints of carbonic acid, a temperature of minus 95° F. may be obtained in a few minutes.

At a dinner given in New York by E. R. Bell to

Rev. Dr. Morgan Dix and others, there was eaten a turkey killed ten years ago and which had been kept frozen ever since in the possession of Mr. Bell. It was found perfect in shape and without taint of any sort, but its meat was devoid of taste. The fat and juice had entirely disappeared, leaving only bones and muscular fiber.

The Colorado Automatic Refrigerating Co., of Denver, seems to have made a success of the business of supplying cold by street mains. The street pipe consists of three lines of extra strong ammonia pipe, laid in cement, and with special steel fittings. One pipe is called the liquid line, for carrying anhydrous ammonia under pressure, and is 1¼ inches in diameter; another, two to three inches in diameter, is the vapor line, for carrying back the expanded gas after it has performed refrigeration; the third, the vacuum main, about one inch in diameter, is used to remove any accumulation of gases from the main or branch pipes. As there is a pressure upon the gas in the pipes in transit, there is no loss of refrigeratory power in transit. The pressure is about 150 pounds. It is said that one pound of the ammonia has the same cooling power as three of ice; and the refrigeration has the advantage of being absolutely dry. The temperature of a large commission house butter store room is held at 42° F. by contract; and the meat room of a market at 36° F.

An inventor in Buffalo, N. Y., has devised a process for making ice by utilizing the intense cold created by the expansion of natural gas when liberated from the

high pressure at which it issues from the wells. In the experimental plant the gas is used at its initial pressure of from 150 to 200 pounds to drive a small engine. After use in the engine the gas exhausts into a closed box, and the expansion generates sufficient cold to form slabs of ice three inches thick to the amount of three-quarters of a ton in a day.

ARTIFICIAL PRODUCTS.

A new substitute for butter, "Le Dansk," has for its basis the fat from freshly-slaughtered cattle, which is first converted into oleomargarine and then into the new product. The fat is cut small, melted at 50° C., turned into water-jacketed tanks, where it is kept 2½ hours at the same temperature, then drawn off into shallow vessels where it stays 36 hours at 32° C., becoming crystalline. The oleo is then pressed out, placed in jars with certain proportions of new milk, oil, and pure butter, and churned for fifty minutes. The contents of the jars are then removed, cooled, salted, worked, and packed.

Fremy & Verneuil's experiments on the artificial production of rubies on a large scale seem to have been successful. The crystals obtained have been employed as pivots in watches. The process consists in heating alumina and a trace of potassium bichromate, with barium fluoride, or a mixture of fluorides of the alkaline earths, to a high temperature for several days. The addition of a small quantity of potassium bicarbonate aids the formation of the crystals. By employing crucibles of several liters capacity, in gas furnaces, as much as six and a

half pounds of rubies are obtained in a single operation.

Artificial ivory has been produced by the use of tribasic phosphate of lime, calcium carbonate, magnesia, alumina, gelatine, and albumen—the same materials as exist in the natural substance.

A French manufacturer has discovered a substitute for celluloid, which he has named hyaline, that possesses the very great advantage of being non-inflammable. It is composed of colophone, lac, copal, Dammara resin, essential oil of turpentine, and gun cotton, and is described as grainless, odorless, transparent, and tenacious.

It is said that an improvement has been made in the manufacture of glass for optical instruments, by the addition of phosphorus and chlorine to the ordinary materials; permitting a much greater degree of polish, so that microscopes can be made to render visible objects only $\frac{1}{8,000,000}$ of a millimeter in diameter; the present smallest limit being $\frac{1}{16,000}$ of a millimeter. This seems too good to be true.

A substitute for glass offered by Eckstein, of Vienna, is made by dissolving from four to eight parts of collodion wool in 100 by weight of ether, alcohol or acetic ether, and combined with two to four per cent. of castor oil or other non-resinous oil and four to ten per cent. of Canada balsam or other soft resin. The compound, when poured on a glass plate and dried by air at 50° C., solidifies into a glass-like sheet or plate, which will resist the action of salts and alkalies

and of diluted acids ; is transparent, odorless, pliable or flexible, and highly infrangible ; while its inflammability is less than that of the collodion substitutes. The addition of magnesium chloride or of grape sugar reduces the inflammability, and the addition of zinc white or heavy spar makes it look like ivory and adapts it for use in making collars, cuffs, etc.

FILTERING AND PURIFICATION OF WATER.

Filtering on a large scale is now being done by one type known as "Torrent" filters, consisting of tanks about six feet square filled with filtering material through which the water to be purified is forced. When the filtering material is choked with impurities, a current of air is blown through from the bottom, and the dirt, having become thoroughly separated from the medium, runs away to a drain.

In a new circulating filter invented by Norris, of London, the water is caused to circulate up and down through the filtering material by a series of intercolated vessels, which, without the complication of any kind of a joint, act as partitions and compel the water to take a circuitous path instead of the shortest. The carbon is contained in an inner vessel, which may be lifted out for inspection or cleaning, and this inner vessel has, in its center, a tube or well rising up and also descending through the bottom ; having at its closed end a number of fine perforations. This tube is filled with loose coarse carbon, and over and around it is a second or air vessel, much larger, and having a flat top from which an air tube rises. This air vessel being in position, is filled by its air tube with fine

carbon to its flat top. The rest of the fine carbon is poured around the air vessel into the space between it and the inner vessel, a flat plate is dropped on the top of the carbon to break the force of the water, and the filter is ready for use.

A recent French method of softening water for industrial purposes consists in employing hydrated oxide of lead, which precipitates the carbonates, sulphates, and chlorides. It being necessary to obtain the hydrated oxide of lead cheaply, this is accomplished by placing a solution of sodium nitrate in a vat, divided into two compartments by a diaphragm ; lead electrodes of large surface are placed in the solution, and a current from a dynamo then passed through ; the sodium nitrate is decomposed, caustic soda being formed in the negative compartment, and nitric acid at the positive pole, from which it dissolves a certain quantity of lead, forming lead nitrate. When the current has passed through the liquid for a certain time, the solutions are run from the two compartments into a second vat and there mixed by means of an agitator ; the soda precipitates hydrated oxide of lead and itself forms sodium nitrate; the solution being then filtered, and the nitrate solution again submitted to electrolysis. On the lead oxide becoming used up, it is replaced by freshly prepared oxide.

BREWING.

A new brewing product, corn beer, or beer made from maize, is being made and consumed in quantities in France. It is made without admixture of barley malt.

An invention by F. Hofmeister, of Munich, Germany, consists in accelerating the rate of fermentation in liquids by spreading the ferment over a large surface immersed in it. Strips of material are coated with old must, beer, etc.; the tun is closed, and a current of air drawn through it for 36 hours. Then the must is run into the tun.

TANNING.

A new tanning material, Canaigre, is the raw stalk of a polygonaceous plant growing in Texas and New Mexico. It is said to tan as quickly as Japonica, and give the stuff a fine pure orange color, differing from the color given by any other tanning material; leaving the leather plump, without swelling, and the grain soft. Its price is $90 per ton, and one ton takes the place of four of oak bark, or four and one-half of pine bark, in tanning upper leather. Its cultivation is like that of the potato.

A much sought desideratum, namely, a really practicable method of waterproofing leather and raw hides, is claimed to have been practiced by an Austro-Hungarian chemist, with much success; his method being to impregnate the material with a gelatine solution, combined with some mineral salt to coagulate the gelatine in the pores. An effective mixture for producing the desired result is found to be the following: Twelve hundred parts water, fifteen parts gelatine, and five parts potash bichromate; or fifteen hundred parts water, fifty parts gelatine, and thirty parts potash bichromate. The temperature of the solution may vary from 50° F. to the

boiling point. When the bichromate percentage is small the liquor is mixed cold, and the leather or hide is immersed for a period of some twenty-four hours. As the proportion approaches the point of saturation the temperature must approximate more nearly to boiling and the time of immersion be re-reduced until it becomes momentary.

ALCOHOL MAKING.

Springer's method of producing alcohol has an upper vat in which is placed a ground farinaceous material steeped in three times its weight of water, over an ordinary cooking tub or suitable material to resist nitric acid, having closed steam coils and nozzles for the discharge of steam into the contained mass. Into this vat for each one hundred parts of the grain one part of commercial nitric acid with fifty of water is placed and brought to ebullition and agitation by the steam coils and the nozzles ; the gain by condensation of steam making up for the loss by evaporation. This condition is maintained for six to eight hours, after which the mass stands one day to complete saccharification. Then the nitric acid is partially or wholly neutralized by potassium or ammonium carbonate—preferably neutralizing only half of it so as to give the mass an acid reaction to keep the peptonite in solution and to aid in the propagation of yeast cells. Yeast is now added, and the remaining processes are like those employed in distilleries, except that, just before distillation, potassium carbonate is added to neutralize the rest of the nitric acid.

SUGAR MANUFACTURE.

It is said that the cost of producing sorghum sugar has been greatly reduced by a process which is the same, until the semi-syrup is ready for the strike pan, as in the ordinary sorghum mill. Then the juice is drawn into large tanks and mixed with an equal volume of alcohol; a current of air is blown through it from the bottom, and the mixture is allowed to stand 12 hours. The alcohol combines with the impurities, and the gummy mass settles. The clear mixture is drawn off, the alcohol recovered, and the residue is filtered under pressure. The loss of alcohol is less than one per cent. By this process it is said that actual sugar, to the amount of from 148 to 160 pounds per ton of cane, has been produced.

By a new system of washing sugar with alcohol (Cordero's) the alcohol is used over and over again without being withdrawn from the apparatus; being distilled and condensed in one part of the apparatus while sugar is being washed in another.

An effort is now being made to manufacture sugar in easily sawed or broken tablets, in order to save waste.

EXPLOSIVES.*

Ammonite, a new explosive, consists of pure ammonia nitrate and nitro-naphthaline, dry, ground and mixed in heated edge runner mills. It must be kept free from moisture. Its consistence is about that of

* Other new explosives are described under the headings "Military" and "Ordnance and Firearms."

ordinary artists' oil colors. It can be fired only by a mercury detonator, in which case explosion will be carried from one tube to another, unless there is about an inch interval between them.

Smokeless powder is to be made in large quantities in the United States by the Duponts.

Peat is recommended as a packing material, particularly for breakable packages containing liquids ; also for preserving perishable articles, as meat packed in it will keep fresh for weeks and will eventually dry up instead of rotting. Fresh seafish packed in it have been sent from Trieste to Copenhagen. It will also preserve fresh fruit. It will also enable artificial manure to be used in wet weather.

Mond & Quincke have discovered that nickel combines with carbon monoxide to form a nickel carbon oxide, which will probably be of use in nickel-plating. They say that nickel is the only metal that will so combine.

Ammonia water as a fire extinguisher received a good test at Queensberry, near Hawarden, England, where a still containing ten tons of anthracene oil exploded and set fire to hundreds of tons of pitch. The use of ammonia water from a 50,000-ton tank enabled the flames to be subdued in 1½ hours.

The monosulphide of potassium and of sodium has been shown by Dubois to be a very valuable insecticide ; particularly adapted for Algerian crops, which require potash.

H. Grimshaw states that the tannin contained in tea may be absorbed by suitable animal substances, such as dried albumen, etc., best added to the tea in the dry condition before infusing. It may vary from one to two parts, to ten parts of tea.

Cotton seed oil may be made to absorb melted lead in the proportion of 10 pounds of lead to a gallon of oil, by repeated pourings, the resulting substance being an excellent paint.

Asbestos is now used in connection with India rubber, being woven into sheets which are coated on each side with the gum and are used for gaskets, etc. Asbestos and India rubber woven washers are also made, and asbestos and India rubber woven tape for making steam and water joints.

A test paper for acids, which is much more sensitive than litmus, is made with a tincture of curcuma, in the proportion of one of curcuma, seven of alcohol, and one of water, passed after drying through a bath of 40 drops of liquor potassæ and 100 c. c. of water. It keeps well in tin foil. It will detect an acid in a mixture of one part of hydrochloric acid to 150,000 parts of distilled water; and will detect carbonic acid in spring water.

Mond & Quincke have succeeded in volatilizing iron in a current of carbonic oxide at ordinary temperatures; the deposit from its volatilization giving all the characteristic iron reactions.

Cassella & Co. have introduced three new shades

of diamine blue, which are not turned red by alkalies or by hot pressing ; being unique in this particular among dark blue dyes. There is also a new fast neutral violet specially adapted for cotton printing. This may be used in the usual way with tannin and tarter emetic mordant, and does not develop a bronzy tinge.

One of the discoveries of the year is that of artificial quinine, by Grimaux & Arnaud, by treating the base cuprein contained in the *Remijia pedunculata*, of Brazil, with sodium, and then with methyl chloride.

Tollens has discovered a new class of sugars, having only five atoms of carbon instead of six ; they are known as pentaglucoses.

PHOTOGRAPHY.

THE magic chemistry of the sunbeam, in connection with the no less magic optical plates of the skilled lens-maker, and the results of the researches of the chemist-photographer, have led to some very remarkable attainments in the line of light-picturing ; some of them bidding fair to realize even the wildest dreams of the most enthusiastic photographer of 20 or even ten years ago.

Photography in natural colors is proposed by Lippmann in a communication to the Académie des Sciences. His method is simply to employ the ordinary reagents. The sensitive film during exposure

is floated on the surface of mercury. If a blue ray strikes the sensitive film, it will pass through, and be reflected again through the film, interfering with the incident ray. When the two rays are in the same phase, their phase will be additive, and the sensitive matter be strongly acted upon. At a small distance further on they will neutralize each other, and the film will not be acted upon. Thus the thickness of the film will be divided into layers on which the light has acted, one-half wave length apart, and when fixed and tried it will be, practically, a number of thin plates, having a wave length of blue light in thickness, and will give rise to a blue color when seen by reflected light. The colors obtained are said to be remarkably brilliant.

The Ives process of color photography (also known as composite heliochromy) consists in first making three photographs to represent the effect of the object photographed upon the three fundamental color sensations (in accordance with the theory of color-vision now accepted by all scientists), and then combining these photographs by superposition, either by projection with a triple magic lantern, or in transparent gelatine prints.

Three negatives are made from the same point of view, and by simultaneous and equal exposure on a single sensitive plate (an ordinary commercial orthochromatic dry plate), the operation involving no more trouble or expense than the production of an ordinary negative. One of these negatives is made by means of the red light rays, one by the blue, and one by the green. From these negatives

are made positives, which are projected upon a screen, the three images being exactly superimposed. The light passing through each of these positives is colored by suitably tinted glasses, corresponding to the light rays employed in securing the negatives. These colors are automatically separated and combined, by the action of the transparent positives, so that the resulting image on the screen appears in the colors of the original. If it be objected that this picture is but a transitory and unfixed lantern view, Mr. Ives answers it by producing, by an ingenious modification of his process, permanent transparent positives showing the same wonderful color effects.

When the most delicate colors in the sky and foliage of a landscape, whether the striking contrasts of the Yellowstone, or the soft beauties of forest and meadow, the brilliant and varied colors shown by the polariscope, or the intricate combinations of color in a painting, can be reproduced with such marvelous accuracy as Mr. Ives has done, entirely by an automatic and photographic process, it may be said that photography in the colors of nature has been accomplished.

The lantern positives are made in the usual way, and projected with a single source of light, in an ordinary magic lantern, by simply replacing the ordinary projecting lens with a special front, so that the color photographs can be interspersed among ordinary lantern pictures without causing any delays. Concerning this process, Prof. F. Stolze, Editor of *Photographische Nachrichten*, of Berlin, says: "It cannot be denied that Ives has made a complete success in the solution of the problem, at least for lantern

slides ; and here we can positively state that, theoretically, the process is accurate."

Mr. Henry Sturmey, Editor of *Photography*, London, says : "Mr. Ives, we believe, has got nearer to photography in colors than any other man breathing, though his system is a distinct departure from the recognized methods of photography, and the result is not directly a photographic one."

It is interesting to note that before the publication of the Philadelphia edition of the *Encyclopædia Britannica*, in which it is gravely stated that photography in colors was far from being an accomplished fact, and in which it was insinuated that its exploiters were endeavoring, by their claims, to forward certain stock transactions, Ives had shown his photographs in natural colors at the Franklin Institute, but a few hundred feet from the office of publication of the work in question ; and not only that, but had given in the Academy of Music, in that city, a public lecture on the Yosemite and the Cañons of the Great West, illustrated by numerous photographs in natural colors, taken by himself and an assistant on a recent tour. It is thus the impossible which ever happens.

Photographing in aniline colors is effected by dyeing or coating the surface on which it is required to photograph, with a peculiar compound, which is then converted into a photo-sensitive derivative, and exposed to the light as is usual in photography ; then converting the sensitive compound, wherever it survives (through having been protected by the shadows of the object photographed), into coloring matters ; then developing the picture from a weakly-colored

sensitive compound into well-marked shades of brown or other colors.

Henry Sutton, of Ballarat, Victoria, has devised a system of telephotography, to which he gives the name of telephany.

E. J. Marcy has studied locomotion in water, by photography, in the manner employed by Muybridge with land animals.

The chronophotograph has been applied by Demeny in the examination of the movements of the lips in speaking, the result being to show that the form of the mouth is quite different for the different articulate sounds. With these photographs combined in a zoötrope he has reproduced the movements of the lips by synthesis. The ordinary person finds it difficult to read the words by the inanimate pictures, but a deaf mute, who has been accustomed to read from the lips of the speaker, can do the same from the photographs. By these means a magic lantern exhibition might be given to an audience of deaf mutes.

Friese Greene, of England, has produced a very ingenious machine in which a thin strip of gelatine film runs continuously over two rollers, being wound on one as it is delivered from the other; but it is stationary at the moment when photographs are made upon it. When the film is placed in a magic lantern and mechanism arranged to allow each successive picture to appear for an instant on the screen and to cut off the intervals of change, the continuity of vision

blends the successive different pictures into one gradually changing view. This apparatus has been shown to several photographic societies in England. Such machines will do for sunlit scenes but not for stage representations, because of the impossibility of getting from 45 to 50 views per second with artificial light.

Edison has devised a similar apparatus which he calls the kinetograph.

Photographic cameras of the so-called detective type are now concealed in neckties, and give pictures about 1¼ inches square, sufficiently sharp for portraits to be recognized.

Mr. Alexander Watt has devised an apparatus for developing photographs without a dark room. It consists of a metal case, only slightly larger than the plate, and which can be closed light-tight by a lid. It has two tubes ; one, entering at the bottom of the bath, and which can be connected by a piece of India rubber tubing to a funnel, the other near the top, just above the level of the plate. The former admits the developer to the bath, and the latter allows the air to escape, and serves also as an overflow. The dark slide containing the exposed plate and the bath is placed in a changing bag, into which it is necessary to insert only the hands ; the plate is transferred from the slide to the bath, then the bath is withdrawn from the bag into daylight, and hung up vertically, and then filled with the developing solution. The plate is washed by running water through the bath.

It has been found that by adding oxalic acid to the

ordinary blue-print mixture, the time of exposure is materially lessened.

The phosphogram is a light picture made on a plate coated with phosphorescent calcium sulphide, exposed in a camera to the image of a brightly-lighted colored object. The result is a phosphorescent negative, which may be photographed by applying to it a sensitive film, the negative when developed showing color.

The Kew Observatory has undertaken the testing of photographic lenses and furnishing certificates with them, as with watches, telescopes, etc.

GENERAL PHYSICS.

UNDER the head of General Physics may be included, for the purposes of this work, Optics, Thermometrics, and other branches of Physics not embraced under the special headings of Electricity, etc., which the reader is advised to consult.

A NEW POLARIZER.

In a new polarizer, the result of the Iceland spar scarcity, the ray is totally reflected from the back of a prism of rhomboid section falling upon a black glass with a single sheet of very thin glass over it. The ray is now parallel to the incident ray. A second prism is added to make the reflected ray correspond with the incident ray, the arrangement resembling the old apparatus for "seeing through a brick." The second prism can be rotated. The one

glass sheet absorbs less light than a series of plates, yet the combination is not so bright as a Nicol prism.

PROPOSED THERMOMETRIC SCALE.

Salomon proposes a new thermometric scale having a relation to absolute zero. It starts at minus 273 degrees C.; from this to the freezing point of water it is divided into 100 parts, and so on up; making the boiling point of water 136.6 degrees. It would form the solution of a difficulty found in gas analysis.

NEW AREOPICNOMETER.

An areopicnometer has been devised by Eichhorn, for determining the specific gravity of liquids of which only a small quantity can be obtained. There is a glass bulb filled with the liquid the gravity of which is to be determined. This is filled with the test fluid and closed by an accurate stopper, and the instrument placed in a glass cylinder filled with distilled water of a temperature of 17.5 degrees F. The gravity is at once shown on the divided scale. There is a lower bulb containing mercury, a small glass knob, balancing the stopper, and an empty floating bulb.

THE CYCLOSTAT.

The cyclostat is an instrument devised by Thury to permit of continuous observation, without fatigue to the observer, of a rapidly rotating body. The principle of the instrument consists in causing the revolution, around the axis of rotation of the object to be observed, of a mirror parallel with such axis, and in

observing it in the axis itself after sending the image thereto by two reflections or refractions. In reality the instrument consists of a small prism above and mounted upon a wheel that may be turned at will. The rotating object is always seen at rest. It may serve for the observation of a swinging thermometer, which is read during its motion; or for the continuous observation of a body submitted to centrifugal force.

MERCURIAL WEIGHING MACHINE.

A mercurial weighing machine consists of a tube closed at the bottom and forming a reservoir for mercury. The body which it is desired to weigh is hung upon a hook carried by a cross-bar connected by rigid rods to the upper part of the tube, and by internal rods attached to a crosshead working freely in the tube. To the crosshead is attached a piston made of wood or of a metal tube closed at the end. When a weight is hung upon the hook, the piston is closed to descend into the mercury, which rises in the annular space between the piston and the tube. The weight of the volume of displaced mercury is proportionate to that of the body hung upon the hook.

IMPROVED PHOTOMETER.

Professor S. P. Thompson has invented a photometer, to effect the determination of the two principal focal planes, and of the two principal "planes of Gauss" for any compound system of lenses. By it can be determined the true focal length and the position and distance apart of the two vertical optical centers of the lens system. The lens is mounted upon a

stand, and a parallel beam sent through it from right to left. A screen is moved up until the beam is fixed upon it; then a beam is sent through from right to left, and its focus found on that side. Then both screens are drawn back from the lens at equal speeds until the image of each screen is focused on the other. The displacement given to the screens is equal to the true focal length.

INSTRUMENT FOR DETERMINING FORGING POINTS.

An instrument for rapidly determining the melting points of metals comprises a platinum strip heated by an electric current, which can be varied by resistances. The end of this strip bears against a lever, which carries at its remote extremity a contact piece which can come against the point of a micrometer screw, and then close a small local circuit, in which there are two galvanoscopes. Over the strip there is a microscope having in its field of view the indicator of one of the galvanoscopes. A small quantity of the substance to be melted is placed on the strip and watched through the microscope, the temperature being gradually raised. At each increment of current the micrometer screw is adjusted to just break the local circuit, and when finally the specimen goes away the position of the screw is read. The temperature is obtained by a curve constructed by experimenting with a series of metals the temperature of fusion of which is well known. By this instrument differences of temperature of two degrees C. may be read up to 1600°.

Cailletet has described to the French Physical

Society a way of connecting a metal tube or stop cock to a glass or porcelain vessel, so that the joint shall be tight even under high pressures. The glass vessel is first coated with a very thin layer of platinum at the part where the connection is to be made. This may be done by painting the glass, after slightly warming it, with a neutralized solution of platinic chloride mixed with essential oil of chamomile. The layer of oil and chloride is slowly heated until the oil is all expelled, then the temperature is raised to a dark red heat. On the layer of platinum thus produced, a layer of copper is deposited by electrolysis, and the metal stop cock or tube may be soldered by tin and a copper ring. Such joints have kept tight under 300 pounds per square inch.

The transmission of heat through cast iron plates has been shown by R. C. Carpenter to lessen after they have been exposed to immersion in diluted nitric acid, up to a certain time, after which it remains constant.

The polymeter is a new instrument for indicating the state of the atmosphere, its temperature, relative humidity or percentage of moisture, vapor tension, and dew point or absolute humidity.

Dewar has showed liquid oxygen boiling at a temperature of minus 200° Celsius.

MEDICINE.

The skill of the physicians of the present day, shown in their everyday successful practice among their private patients and in the great hospitals which are open to the afflicted poor, rivals even that of the "skilled leeches" of fiction, who by pouring from a small vial a few drops—sometimes, indeed, but a single drop—of a clear fluid, brought the dying to life and strength, speech and action, within the space of a few minutes at most. The study of existing compounds under various circumstances, and the search for new ones, have given to the medical world a rapidly increasing list of remedial agents which affect special organs and produce special conditions at will; and when one views the cures that are made, and considers the claims that are advanced for the new agents and new modes of treatment, one can but wonder that a single invalid having the money to pay for treatment, and the ability to get within reach of the possessor of the special knowledge of life and death, should remain ill a week.

When we consider the eagerness with which the public seizes upon every new chance of life, and the proneness of quacks to speculate upon the credulity, the fears, and the ills of those who care for them, we should wonder that there are not more cases than there really are, of remedies which, like the Koch lymph (announced to cure lupus under certain conditions, and claimed and believed by the unwise to be a certain cure for consumption of the lungs), blazing forth in the scientific firmament with cometic sudden-

ness and speed, and as suddenly going, like those "wandering hairy stars," to find a dark corner in oblivion.

THE TREATMENT OF CONSUMPTION.

The claim is made by Dr. McCall Anderson that galloping consumption may be cured by keeping up the strength, keeping down the fever, and treating any special symptom or complication that may arise. This is done by having two thoroughly reliable trained nurses, feeding the patient upon fluid food (avoiding soup if diarrhea is present) and day and night giving stimulants. At bedtime a subcutaneous injection of atropine (from $\frac{1}{100}$ to $\frac{1}{60}$ gr.) is given. The temperature is kept down by giving ice to suck, by sponging with iced vinegar and water, or even by iced enemata; but more effectually by Niemeyer's antipyretic pills every four hours, containing 1 gr. quinine, $\frac{1}{2}$ to 1 gr. digitalis, and $\frac{1}{4}$ to $\frac{1}{2}$ gr. opium. Every day 10 to 30 grains of quinine are to be given, either in one dose or all within an hour. As long as the temperature exceeds 100 degrees iced cloths should be put to the abdomen for half an hour every two hours.

Mr. A. Judson Palmer has a note upon the beneficial effect of hydrastis in phthisis, as showed by thirty years' practice, as a local application to inflamed mucous surfaces, and by three years' test with it, in spray, for the lungs. During the first month of treatment the night sweats disappear, the cough and expectoration are diminished, the appetite and digestion are better, and strength is gained. It is best used in the proportion of one part of the fluid extract of

hydrastia can. to three of a saturated solution of common salt; although it is also used with glycerine and water. The inhalations are given twice daily.

The recent experiments in injecting the blood of a dog into the veins of a rabbit have been shown to be very desirable in the treatment of tuberculosis, or, as it is ordinarily called, consumption of the lungs.

Dr. Anders has come to the conclusion that the number of deaths from phthisis is smaller in proportion to the population in wide streets than in narrow ones; and that in the latter it is the greatest where they are long, or where they form *culs de sac.*

Dr. Wm. H. Gregg calls attention to the wonderful value of terpene iodide in diseases of the lungs. He says that it enters into the circulation unchangeably, acting as quickly as though administered hypodermically. In acute affections of the throat it may be used in spray; in other cases it may be given to adults in ten-drop doses on sugar, once or twice a day—in the morning, and at bedtime. The morning dose should be followed up by a glass of milk or bouillon.

Liebruch proposes, as a cure for consumption, the cantharidate of potash, which excites serous exudation from the capillary vessels, and increases expectoration. The dose is one or two decimilligrams, by injection.

TREATMENT OF DIPHTHERIA.

Dr. Sydney-Turner, of Gloucester, England, says that he has treated 30 cases of diphtheria with paraffin (oil) of the kind used in lamps; the diphtheritic patch being scraped off, and the oil applied with a brush to the throat. As a rule the throat got well in 24 to 48 hours.

Loeffler shows that for diphtheria, where there is danger of infection, the best of all treatment consists in using as a gargle, for five to ten seconds every three hours, one in 10,000 to one in 15,000 solution of mercuric chloride, or better, a one in 8000 to one in 10,000 solution of mercuric cyanide. Other good gargles are weak chloroform water, chlorine water containing one of the gas to 100 of water, or a solution of one part of thymol in 500 of 20 per cent. alcohol. Substances active in the vapor form are oils of sweet orange peel (oil of Portugal), lemon, eucalyptus, and spike, as well as anisol, phenetol, benzol, and toluol.

Behring and Kitasato state that they have discovered that the blood of an animal which has been made immune against diphtheria will destroy the poison formed by the microbe of this disease.

REMEDY FOR TYPHOID FEVER.

The new method of treating typhoid fever consists, according to Dujardin-Beaumetz, of Paris, in the use of salol or resorcin to lessen and prevent putridity of the bowels; this by reason of its not being irritant as naphthol is, besides which it is not destroyed as a

medicament by the processes of digestion. The quantity per 24 hours is between two and four grams (one-half to one dram). Salicylate of bismuth may be added if desired. Instead of cold baths, lotions, wet packings, and tepid baths are used ; the baths having a temperature of from 30° to 32° C., or about 10° C. cooler than the body of the patient ; thus reducing the temperature and freshening the skin. The treatment consists, first, in lotion, then, if the temperature exceeds 40° C., tepid baths, one or two per day ; and if the patient is feeble, stimulating drinks while in the bath. To terminate the fever, sulphate of quinine and benzoate of sodium are used. Abundant drinks are given to facilitate diuresis.

TREATMENT OF SMALLPOX.

Pitting by smallpox has been entirely prevented by Dr. Lewintaner, of Constantinople, by antiseptic treatment as follows: the entire head and face, excepting the eyes, are covered with a plaster consisting of three parts of carbolic acid, and 50 parts each of olive oil and starch. The body is covered with a mixture of three parts of salicylic acid, thirty of starch, and seventy of olive oil. The internal treatment consists in giving quinine in acid solution.

HAY FEVER, INFLUENZA, AND WHOOPING COUGH.

Rixa announces definitely that he has been able to subdue hay fever in a number of cases by the following treatment: two weeks before the expected attack, all were ordered to irrigate the nose with warm salt and water four times a day ; then a few minutes after this to spray the nares with peroxide

of hydrogen and chemically pure glycerine, half and half. To those subject to inflammation of the eyelids, a wash of a two per cent. solution of boric acid was given. Three days before the usual onset there were given five grains of phenacetine and five of salol, three times a day. This treatment was kept up through the season until late, when the frequency of application was reduced. All the patients could attend to business for the first time in many years.

Prof. Tessier, of Lyons, has shown that influenza is a growth of Russian soil, and that when not a raging malady it is a smoldering one. It is caused by the way the people live in winter, locked up in hot houses; by the flatness and bad drainage of the soil, and its universally sodden condition when the April thaw begins, and by the filthiness of the farmyards, village streets, and suddenly swollen rivers.

Common thyme has been pronounced by Neovius as almost a specific for whooping cough; the dose being only one and a half to six ounces per day, with a little marshmallow syrup.

THE COMPRESSED AIR TREATMENT.

Corning has a paper on the use of compressed air in conjunction with medicinal solutions in the treatment of nerves and mental affections. The system employs a large cylindrical metal chamber capable of hermetic closure and able to stand 160 pounds per square inch. The amount of air pressure is adjustable at will. It is considered an advantage for introducing the remedy into the system, to get a

certain amount of blood in one or more of the extremities. This is done by ligatures, or tight elastic stockings or bandages. The medicinal remedy is then introduced by mouth or rectum, or hypodermically. The patient enters the chamber, the air pump is set in motion, and by degrees the compression of the air progresses—say up to thirty pounds per square inch. At the end of the desired time the pressure is very gradually lowered; and during such reduction the bandages are removed by the patient. At the same time he swallows aromatic spirits of ammonia to which tonic has been added.

MEDICAL PREVENTION OF SUICIDES AND MURDERS.

Dr. Haig has shown the influence of uric acid in causing headache. He proved that the urine secreted during the headache always contained a considerable excess of uric acid in proportion to one in twenty or one in twenty-five to the urea, while that immediately before the attack contains a diminished quantity. He found that by influencing the secretion of uric acid he could influence the headache as well; acids relieving or removing the headache while alkalies made it worse. He also found that by giving acid for a day or two he could store up uric acid in the tissues, and then by giving an alkali could wash it out into the blood and urine, and bring on an attack of headache at will. He has shown that if uric acid is first removed by salicylate of sodium, a dose of alkali will produce another and plus secretion of uric acid and a headache. He found in epilepsy a minus excretion of uric acid preceding, and a plus secretion accompanying. He found that the chief substances which diminish

the excretion of uric acid in the urine are acids, iron and lead, and opium ; those which increase it, soda or potash under certain conditions, phosphate of sodium, and salicylates. He states that milk, fish, and eggs constitute the only animal food completely removing the attacks without the use of any drugs, and that a man eating meat three times a day, drinking acid beer and wine, may keep back and store up in his body several ounces of uric acid in a few years, while on the above diet he would not store up as many grains. He believes that many a case of suicide, and some murders, might be prevented by a timely dose of acid which would free the brain circulation from the power of the acid.

Tunker has found that the blood during life contains less sugar than after death, and that that of persons suffering from cancer contains more sugar and reducing substances than that of healthy persons, or those having other diseases.

Sciolla shows that the density of the human blood diminishes during acute febrile states and the first stages of convalescence, increasing with greater or less rapidity according to the nature of the disease. The blood serum increases in density as soon as there is any improvement in the patient ; it is diminished in malaria, while that of the blood is diminished. Ordinary tuberculose diseases only slightly modify the density of both serum and blood. Both are diminished in catarrhal jaundice. In cirrhosis of the liver, and cancer of the gall-bladder, the density of the blood is almost normal, while that of the serum

is increased. In mild forms of diabetes the densities of both are not greatly diminished. The greatest diminution in the blood density occurs in diseases accompanied with grave morbid changes in the blood; particularly pneumonia. In typhoid fever the albumens of the blood diminish unless the diarrhea is excessive.

It is proposed to use the bottom water of the Dead Sea as an antiseptic. It is easily charged with calcium salts, and bromide of magnesium. In an attempt to cultivate in it various kinds of bacilli, those of diphtheria, measles, scarlatina, smallpox, etc., died at once; those of tetanus or of gangrene being the only ones which survived 48 hours.

A new local anæsthetic is chloride of ethyl, a colorless mobile liquid having a peculiar and pleasant odor and a sweetish burning taste. It is furnished in sealed glass tubes; when required for use the point of the tube is snapped off, and the heat of the hand causes the chloride to be projected in a fine stream which may be directed upon the part affected.

A substitute for quinine is afforded in pambutano, the root of a shrub.

Hunger has been shown to be favorable to infection by anthrax.

The juice of the unripe cocoanut is used with great satisfaction as a culture food in bacteriology.

Dr. Bordas states that he has isolated and cultivated the microbe of rheumatism.

Herstey reports that several cases of gastric ulcer have been cured by an ice-cream diet, and ascribes its efficacy to the local anæsthetic action of the cold permitting digestion to go on without pain while sufficient nourishment is supplied.

SURGERY.

THE introduction of anæsthetics, and the great advance in antistyptic dressings and treatment, have rendered it possible to perform many operations which perhaps could have been done by the surgeons of old, had they been furnished with facilities of a grade equal to their knowledge of anatomy and to their skill of manipulation.

The most remarkable or most prominent case of the past year has been that in which the attempt was made (too late, unfortunately) to graft part of the bone of a dog's leg to supply the place of a short length removed from the shin of a boy. As showing that it is possible to cause perfect union between healthy bone tissues of dog and man, and, during the operation, to establish pefect identity of nourishing circulation between the two animals, the human and the canine, the attempt was a success. But the number of times that the unfortunate cripple had been tortured unsuccessfully for the treatment of the poor cracked limb, which had been broken and reset, broken and reset, time out of mind, militated against the success of this operation, while leaving its projector and the public reasonably sure that under more favorable circumstances, with the knowledge and

experience gained by a test of the past year, the operation, or kindred ones, will be brought to the desired conclusion.

Skin-grafting has been rendered much more easy by a process for removing strips of human skin about $\frac{1}{50}$ of an inch thick, an inch wide, and six inches long, by a shaving apparatus.

In Chicago 132 Knights Templar submitted themselves to the surgeon's knife in order that a smooth piece of flesh might be taken from each to be used in skin-grafting on a brother member, upon whom an operation had been performed for cancer. There were 144 square inches to be covered. A failure resulted. He died Febuary 24; his stomach having given out, his system having been overtaxed by numerous operations; and when nourishment failed the wounds ceased to heal.

A remarkable case of the successful removal of a piece of metal embedded in the retina is reported by Dr. Tatham Thompson, the ophthalmic surgeon to the Cardiff Infirmary. A blacksmith was engaged in December last at a colliery near Pontypridd in stamping new tools, when a small splinter of steel flew off and struck him in the white of the left eye, causing irritation and other symptoms which eventually rendered it necessary either to remove the eye or to make an attempt to extract the cause of the trouble. The latter daring experiment being decided upon, the patient was put under the influence of ether. The little wound was then reopened with an instrument

known as a cataract knife, and the curved pole of an electric magnet was introduced. This was then passed across the vitreous body, as nearly as could be judged, in the direction traversed by the splinter. On the first withdrawal nothing appeared, but the second attempt, in which the pole was passed still further, ended in the fragment of steel passing easily through the opening in tow of the magnet. The sufferer has since resumed his duties, with restored sight.

It would seem that laparotomy was not necessary in cases of swallowing foreign bodies, such as nails, screws, etc.; the course at present adopted being feeding the patient on nothing but potatoes, which increase the amount of fæces, thus affording an excellent opportunity for the foreign substance to be passed out *per vias naturales.*

PRINTING AND TYPEWRITING.

THE GREATEST PRINTING PRESS IN EXISTENCE.

WHAT has been claimed by its owners, the proprietors of the Philadelphia *Item*, as the greatest press in existence, is a quadruple press of the Hoe web perfecting type. Its owners say of it: "The capacity of this press is limited only by the conditions of paper and roller composition. If the paper is of sufficient strength, and the rollers all right, the Hoe quadruple can be run at extraordinary speed, surpassing anything yet attempted or anything expected. . . . . We made the trial run (to break all previous records), and with two stop watches, we got an

actual output of 1060 eight-page papers in one minute. This record was made in the presence of Mr. D. L. Ward, of Bulkley, Ward & Co., of Philadelphia, and verified by him. This would show a speed of 63,600 eight-page papers, or 127,200 four-page papers to the hour. We believe that this press is capable of running 1200 eight-page papers to the minute, although we do not think such a speed advisable. Our regular running speed is 50,000 to 55,000 eight-page papers to the hour. We use good paper, good ink, and the best rollers. This speed is 10,000 higher than that of any quadruple press in operation in New York City."

IMPROVEMENTS IN COLOR PRINTING.

Oldfield, of London, has produced a process of printing by which any number of colors may be printed at one operation by an attachment which may be made to any Wharfdale or cylinder machine. The device is not suitable for pictorial work, but for posters and circulars in which successive lines are printed in different colors and the whole surrounded by a colored border. To print a black circular, with a red headline and a green border, the form is placed in the machine so that the line of type runs in the direction of the machine. There is an ink slab in line with the upper headline of the same or slightly greater width, and supplied with ink of the desired headline color; this inks the main inking roller. The main body of the circular is inked by another slab supplying only black ink to the roller, and the top and bottom borders are inked from two other small slabs. As the borders come under the main inking roller the latter is lifted clear of the type by small strips of

wood on the moving carriage, which run under the ends of the roller, thus raising them clear. The side borders are inked by a distinct set of rollers which take their ink from separate slabs, and as the form passes under them are lifted clear of the type by wooden slips as with the main inking roller; but these slips are cut away at the proper places to let the roller down at the moment the colored side border is passing underneath it.

A rotary press for printing several colors at once has been brought out by Marinoni for printing the illustrated supplement of the *Petit Journal.* It is printed on one side by one cylinder and on the other by four, each printing a separate color; the first side being reserved for the text. It may be arranged for printing two copies broadwise. The difficulties of impasting have been solved by striating the plates. It uses relief blocks made from isochromatic photographic plates. The machine can give the delicate tints of aquarelle by superposed colors, the intervals showing the white of the paper. The maker is now building a machine for printing in six colors.

TYPESETTING MACHINES.

There seem to be in the market and in use several typesetting machines that may be said to be practical, inasmuch as daily journals and large book printing establishments are equipped with them and running successfully; but legal complications among their patentees and owners appear likely to postpone their day of universal adoption.

Earl Beals, of Muskegon, Mich., has invented two,

the first of which corresponds to a typewriter, and is operated by a compositor, who works from the copy.

This, instead of being printed, as by a typewriter, is transferred to a strip of paper by perforations made by striking the keys on the fingerboard, the particular letters or characters being determined by the distance of the perforation from a base line.

When the copy has thus been transferred to the strip of paper, the latter is taken to the second machine, which is worked automatically by electricity, and, as each line is composed, impresses it into matrix paper in a way that makes a perfect mold of the line. The matrix paper moves along automatically as the lines are composed, until a mold is obtained for a column.

It is then ready for the electrotyping process. It is claimed that it can be operated as rapidly as a typewriter. The automatic aligning and impressing machine will be capable of handling the matter turned off from two or three of the perforators. The capacity is said to be equal to about twenty men at the case.

BASE FOR ELECTROTYPES.

A new and secure base for electrotype plates is said to be made by taking the plate off the usual wooden block, fitting it with very strong wire pins, which are to be bent into hooks at the back of the plate; the plate being then mounted on Portland cement poured under it. It is said that one thus mounted has been treated for warmth, cold, and damp, and stands any amount of printing without alteration. Plates thus backed have been in use three years as an experiment.

BOOK TYPEWRITER.

A typewriter for working in bound books, as those of record, the desirability of which machine was first pointed out by the writer, some years ago, is said to have been produced by Austin Lowe, of Minneapolis, Kan. It may be clasped to the book, and strikes directly downward.

ELECTRICITY.

Of all the arts and sciences, electricity has made the most advance during the past decade ; but it cannot be said that in 1891 there have been made any colossal strides in any one direction, the advance being all along the line, and being due to steady research and increase of expertness. The new science has become the ally of every useful art, of most of the ornamental lines of human occupation and amusement. It has been promoted to the studio of the artist, installed in the domestic kitchen, called upon to serve the hospital, enlisted in the active participation of commercial and manufacturing business, pressed into the army and navy, and altogether made the handmaid of the useful and ornamental arts, the advocate of the nation, and the angel of the fireside. It now embraces more ramifications and complications than its most enthusiastic follower could or would have predicted a score of years ago ; and more than may be laid to the count of any other science.

Glancing along the line of electrical work, and of electric research, that department in which most prog-

ress has been made seems to be in the development of the alternating current, particularly for long transmissions of current for lighting and for power.

Of the strictly professional work in this line, the paper by Nikola Tesla is the most interesting, and, with the experiments which accompany it, the most remarkable; showing among other things how light may be produced wholly by induction in lamps or in illuminating surfaces carried about free from electrical connection of any kind, in an ordinary apartment. The limits of such a chronicle as this do not permit of giving even an abstract of this wonderful discourse, which is now recorded in a form easy of access by any student of modern electricity.

THE ELECTRIC LIGHT.

During the month of December an interesting lighting experiment was tried at the Eden Musée, New York, with four automatic arc focusing lamps at as many different points around the gallery; these lamps receiving current from the regular incandescent circuit. There was no glare, by reason of the use of lenses; but the entire auditorium was flooded with light. The incandescent lamps which were burning were not interfered with. It is proposed to install four of these reflectors in large vases which will conceal the source of light while throwing rays in all directions.

Somoff is making incandescent lamps for inspection of the human stomach or bladder, the smallest lamp being but three millimeters in diameter and five long. It is a one-candle power lamp requiring from three and

one-half to twelve volts. Even with the higher voltage, the small amount of current (0.2 ampère) would not heat up the globe to any more than the temperature of the human body.

A new electric railway lamp has a carbon support for the filaments, sealed in the tip of the bulb, preventing excessive vibration and rupture of the filament.

A new way of repairing incandescent electric lamps, invented by Pauthonier, is described in *The Electrician.* The lamp has pierced in its bulb a hole large enough to let the old filament be taken out; then, the old one being cut off, all but short pieces, a new one is welded to those stumps, by filling the bulb with a liquid hydrocarbon, and introducing the new filament. One end of the filament being pressed against the stump of the old one, and the current passed through the joint, the hydrocarbon is decomposed, and the two ends joined. Then the other ends are welded in the same way. Next, the glass is bleached.

A very simple incandescent lamp socket is nothing more than a coil of brass wire mounted on a wooden base, one end being fastened under an ordinary screw; in the center of this coil another screw is set into the board, its end projecting on the opposite side, and this screw forms the other terminal of the lamp. An incandescent lamp may be screwed into the socket in the ordinary manner, and in wiring it is only necessary to attach one of the lead wires to the projecting end of the screw on the back of the base, and attach the

other lead wire under the second screw on the front of the board base. It is claimed that with this socket, which is for temporary work, one man can wire 50 lamps per hour.

A flexible lamp support consists of a universal joint, made up of metal rings and capable of being twisted into almost any conceivable curve.

Mr. C. F. Brush has put up, at his residence in Cleveland, an electric light plant, consisting of a windmill 56 feet in diameter with a surface of 1800 square feet, mounted on a tower 60 feet high and driving a dynamo working accumulators. The whole tower is carried around on a fourteen-inch wrought iron pivot. The main shaft is 6½ inches diameter and 20 feet long. The entire weight of the dynamo, countershaft, pulleys, and belts is carried by this, the weight being 4200 pounds. The dynamo makes fifty turns to one of the shaft. The electro-motive force cannot rise above 90 volts. The current is led to 408 accumulators, divided into 12 batteries. Each cell has a capacity of 100 ampère-hours.

The use of the electric light on the Suez Canal has reduced the time of transit from 36 hours to 24.

The new electric lamp in the lighthouse on St. Catherine's Point, Isle of Wight, is the most powerful in the world. The light is equivalent to that of 3,000,000 candles, and it can be increased to that of 6,000,000. It is visible at a distance of about forty-five miles.

A new electric lamp for lantern projection consists

of a small metal box in two parts, bolted together and insulated from each other at the joints. There are attached to this box two tubes, one on each side, each holding a carbon pencil, one of which is hollow and has sliding freely in it an auxiliary carbon rod. The lower carbon is solid. Between the two large carbons there is a block of marble, which has an opening in one side. The marble block keeps the two large rods at a fixed distance apart, but the small rod slides down and makes electrical contact, to start the light; then it is automatically withdrawn. The marble block is brought to a white heat.

In a new projecting lamp the carbons comprise a rod concentric with a tube, and the arc is constructed by removing the rod from contact with the side of the tube into a central position. In some of the models a series coil is placed around the carbons to shift the arc into the desired position, or to push it forward so that it could be used as a blowpipe. Such a lamp would probably work best with alternating currents to keep the carbon consumption even.

Wertz, of New York, has produced a combination arc and incandescent lamp. The carbons are in a glass globe, and burn so slowly that no feeding is required. There is a short, thick, hollow carbon, within which is a second one as a core, there being an asbestos sheath to prevent their touching except at the top, where the inner one has a large round head, which rests upon the upper end of the outer one. It is intended for high tension series working.

RECENT DYNAMOS.

The great Ferranti dynamos at Deptford Central Station, London, are of 10,000 horse power each. The armature rings are 35 feet in diameter, and with their shafts weigh 225 tons each. The field magnets weigh 225 tons each, exclusive of the bedplate. One 5000-horse power engine is at each end of the shaft. There are to be five such dynamos, each supplying 200,000 incandescent lamps.

From the ground to the top of the high pressure cylinder of the engine is to be 48 feet. The over-all dimension of the dynamo is 45 feet, of which 16 is below the floor level.

In the latest type of Siemens compound-wound dynamo, with drum armature, wrought iron field magnets have been used, of smaller cross section than those adopted by many makers, and these have been wound with the series wire on only one limb, simplifying the connections. The armature is of iron disks, and the conductors consist of strands compressed into rectangular bars, arranged around the armature in the usual way.

In the Winkler dynamo there is a Gramme ring which furnishes the exciting current, and a Siemens winding, which furnishes the working current; and there are two commutators, one for each of these windings. Between the two end plates and insulated from them is a series of iron conductors dropping below the periphery of the end plates nearly to the shaft, and connected across their tops to form a Gramme

winding. Before the upper connecting bars are put in position, however, insulating material is placed over the frame formed by the armature conductors, and iron wire is then spun upon the armature as in the ordinary Gramme construction, until a solid mass is built up flush with the end plates. Then the connecting bars are put in position, the insulation plates between them, and the core finished up, giving the Gramme rings with a comparatively small number of segments formed of iron conductors. The requisite amount of magnetic material being furnished by iron wire, laid on after the armature is finished to this point, it is wound just as any other drum armature would be, with a single layer of copper. This gives two distinct circuits upon the armature, one a Gramme winding capable of delivering the exciting current for the field magnets, the other an ordinary Siemens winding of sufficient power to give the desired voltage. The field coils are compound-wound, the principal magnetizing circuit being connected to the Gramme winding. A compound winding of the ordinary sort is supplied outside of the coils of the separately excited circuit. One of the objects of this construction is to avoid the severe self-inductive shock that can be received from the powerful shunt coils of an ordinary machine.

The Brush Company has produced a generator for the transmission of power, being of the closed armature type, the core of the armatures being made up of thin sheet iron wound on a foundation ring and riveted. The edges of this ring are then milled out slightly to allow for the bobbins. The wires from

the armature to the commutator are carried along the shaft and are well covered. The bearing on the commutator side of the dynamo is outside the commutator to allow a clear way for the connections between armatures and commutators. No outside governor is required. They will be wound for 1000 volts. The commutator is said to run with practically no spark.

Parsons & Co., of Newcastle-on-Tyne, have brought out a steam turbine and electric current dynamo combined in one frame. The speed is 4500 to 5000 turns per minute.

A 1000 H. P. dynamo for the electrolytic reduction of aluminium has been designed by Willson. The pulley by which it is run is five feet in diameter, and the armature is two feet in diameter and four feet long.

This dynamo is of the Gramme construction, the armature weighing 6163 pounds and the frame containing 11,000 pounds of castings and 7000 of solid forgings. The machine, with a small pulley, weighs nearly 30,000 pounds. The designer intends it to put out 750,000 watts if necessary.

In a system of belting proposed for dynamos the fly wheel of the engine is made to bear on the top or slack fold of a horizontal belt connecting the dynamo shaft with an idler pulley, which swings in a frame. When the slack top fold is brought up against the under side of the fly wheel (or other driving pulley on the engine shaft) the dynamo is driven ; but slack-

ing the belt does away with the contact between the driving pulley and the belt, and of course stops the motion of the dynamo without arresting that of the engine.

A new carbon brush holder for motors and dynamos consists of but five parts, yet without a screw or a nut to work loose and fall out. A play of three-quarters of an inch allows adjustment in either direction when the commutator becomes worn, while the carbon brushes may be removed or replaced with a single hand while the machine is still in service, thus avoiding the possibility of a shock.

ELECTRIC POWER STATIONS.

The Edison Electric Illuminating Company, New York, is building, at Pearl and Elm streets, a station with a capacity of 30,000 horse power, the engines being of the vertical four-crank four-stage type with initial pressure of 220 pounds ; each engine being of 5000 horse power. The radiant heat of the engines, machinery, and piping will be made to flow over the boilers and through a piping gallery and an arrangements of pipes in the chimney flue ; being finally discharged into ash pits and over the grates in the proportion of 80 and 20 per cent. respectively, at a temperature of 200 degrees. The steam mains will be of copper, none over eight inches in diameter, and each wound with steel wire for its entire length and corrugated into the flanges, no brazed joints being used. The chief electrician expects to reduce the coal consumption to one pound per horse power per hour.

The West End power station in Boston will surpass anything of the kind that has ever been built. In October there was started one of the two engines in place of the 13 which it is expected will be in use when the plant is completed. It is triple expansion, drop cut off; with 28-foot fly wheel, ten feet seven inches face, weighing 80 tons, and using two belts each four and one-half feet wide, running 6000 feet per minute. The countershaft will be in sections of 40 feet long, with friction clutches, so that there will be two lines of shafting, 240 and 280 feet long respectively. There will be 34 electric generators each of 500 maximum horse power; height nine feet, width eight feet, length 16 feet and weighing 35 tons each. The engine house is 315 feet long and 170 wide. The boiler house, 160 feet long, 80 wide, will contain 24 boilers with a stack 252 feet high. The station will have a capacity of 12,000 horse power, and the Cambridge station 5000, for operating 850 long cars.

ELECTRIC RAILWAYS.

In the Love electric conduit system, in Chicago, the conduit is but 15 inches deep, and, as the slot rails are readily detachable, may be easily cleaned. The copper conductors, or trolley wires, form a complete metallic circuit, and are supported on glass block insulators, through the center of which the wire passes. The trolley has two contact wheels for each conductor, so arranged by springs that it will press against the conductor at an ordinary angle.

A new electric railway type (V. V. Vansize, Plain-

field, N. J.) has a series of secondary batteries in cellars, or other convenient places along the route, one-fourth to one-half mile apart; these are connected to a high tension charging current, which is completely insulated from the discharging and working current. The track is divided into a number of these circuits, the rails being the conductors. By connecting the secondary batteries with the high tension current in series, and with the discharging current in multiple, a low working pressure can be got.

In the Gordon electric railway system the conduit carrying the current is very small; the supply rail is midway between the two line rails, and consists of flat iron, laid in concrete, in eight-foot lengths. The sections are charged by the full current of 400 volts, as the car progresses, so that no section is charged except those under the car. This is done by a system of connections laid in a gas pipe, with T-pieces connecting to each length and back to a communicating box, which is the feature of the system. These boxes are placed, every 100 yards, under the curb, and contain strong long-pull magnets, one for each section. As the car progresses, a shunt current comes back from section number one to magnet number two, which rises and puts section number two in connection, cutting off number one, and so on, as the car moves, the main reaching the entire length of the road. The pull of the magnet is about seven pounds. The conduit is closed; no slots or wires that can be touched are needed. By the addition of one contact the absolute metallic return of the current

can be made by way of the section behind, thus avoiding difficulty with the telephone companies.

A new method of haulage by electricity has been brought out by Walker. The locomotive does not get its grip by reason of its own weight, but has a direct pull on a cable lying between the rails, parallel to the road, and fixed at either end. This cable passes over a sprocket wheel on the locomotive, or trolley, and is driven through suitable gearing by an electric motor supplied with current from a bare copper wire on the roof or at the side of the road. Its advantage lies in the light weight of the trolley in proportion to its tractive power.

A new parcel-exchange system is proposed by Bennett with a view to overcome the trouble in many large towns that the vehicle traffic is so great that, in order to avoid absolute blocking of the thoroughfares, the collection or delivery of goods is forbidden in special districts in certain hours. The plan is to enable the interchange of parcels between any number of buildings, no matter how widely apart they may be, by a number of miniature underground electric railways, radiating from a central station having branch lines or sidings into all the buildings to be served; the tracks to be in rectangular tubes, with the up-track in the top and the down-track in the lower part. Each train will consist of a motor truck and from one to three trailers or other trucks. Connections with the premises of subscribers would be by short branch spurs from the nearest main line. Mr. Bennett says that a mother could send her baby

bodily to a doctor, via the central station, and receive it back with a bottle of medicine in its fist and a mustard leaf on its chest.

The electric railway at the World's Fair of 1893 will be really a traveling sidewalk on an elevated structure, 25 feet high, 900 feet long, in the form of an ellipse, and consisting of 75 cars, each twelve feet long, connected into one solid train. There are to be two parallel sidewalks, one running two miles per hour, and the other four, both moving in the same direction. The passenger may step from the stationary walk to the slow moving, and from that to the fast moving one, and may walk upon either one if desired. The entire train will be worked by one man. There will be, at a central point one side of the track, a controlling station containing a main switch, reversing switch, automatic circuit breaker, lightning arrester, ampère meter, and rheostat, all arranged so as to be operated and controlled by one person.

A new railway line and insulator (the Winton) has interlinking hooks inclosed or embedded within the insulating material, preferably hard rubber, the hooks being separated from each other by a layer of hard rubber fastened between them and also covering the whole body piece. Each interlocking hook has a threaded stud projecting from each end, one to receive a clamping ear, and the other to receive supporting pieces to be attached to a wire of the bracket.

A new threading device for underground conduits consists of short rods having locking joints, the first

one having a cartridge point and the last one a swivel to which the wire may be attached. It is claimed that the time of pulling a wire through a conduit is reduced 80 per cent. and that crooked wires may be drawn through by reason of the swivel.

The Fullerton Avenue electric railway, on the conduit system, is under way in Chicago, exploited by the Love Co.

Vienna and Pesth are to be connected by an electric railway on the left bank of the Danube, saving 19 miles in 140 by taking steeper grades. The speed contemplated is 62 miles per hour.

The first overhead tramway in England was started in Leeds October 29, the Thomson-Houston system being used.

Electric railways are proposed in Berlin. Three projects are made, of lines to be laid at different levels to avoid complications; one, north and south, to be double track, and nine meters underground; to be in an iron tunnel covered with cement; to have 14 stations.

The Honolulu tramways are to adopt electric traction by reason of the great cost of forage on the Island.

A safety fender for electric railway cars consists of a triangular steel frame projecting from the frame of the car, on each side, the two frames being connected

by steel rods at the bottom. Over this frame is a stout rope netting. The front and bottom of the fender are raised nine inches from the rails, to catch and throw into the net any person standing on the track, no matter at what speed the car might be running. In case the person was lying flat on the track, or in case of a small child that could by any means pass under the fender, a projecting arm would be struck, releasing a scoop which drops down to the track in front of the wheels. At tests made in Newton, Mass., with a dummy of straw and sand, the latter was thrown into the netting in every case.

The Des Moines S. R. W. Co. has an electrical track sweeper or cleaner, the parts of which are so devised that the running gear and propelling motor may be used for conveying passengers in summer, and for sweeping and track cleaning in winter.

ELECTRIC RAILWAY MOTORS.

In the Henry electric motor for street railways, all spring supports are deliberately avoided ; there is but one motor instead of two, and only one pair of wheels is driven by the gearing, either being operated by a connecting rod. This construction lends itself only to good track construction. The motor is rigidly fastened to the steel frame connecting the axles, its ends having bearings on three-inch steel axles parallel with the axles of the wheels. The magnetic circuit has but two joints, and is in form similar to the Reckenzaun type. It is very short in the windings, very compact ; there are two consequent poles that embrace a Gramme armature 18 inches in diameter,

The armature is wound with two layers of No. 7 wire in 72 segments each, connected to its appropriate commutator bar. The winding is continuous throughout, loops being taken out at the commutator instead of the wire being cut. The fields are wound with No. 9 wire, the four coils arranged for three combinations at the switchboard, two in series, two in parallel, and all in parallel, thus giving three speeds. The wire is very large and the internal resistance very low, making it desirable to have some arrangement for driving the truck through a clutch instead of starting the motor each time. The clutch consists of a epicyclic gear which can run freely when the pinion is free to move, and exert its full power when the pinion is held as fast as it can be by a clutch lever. The armature runs all the time, and can be allowed to get its full speed before any of the load is thrown on. The epicyclic gear runs in a case full of oil. There is an automatic brake consisting of two friction wheels, one on the axle and the other upon the shaft supporting one end of the motor; the latter is arranged with an eccentric, so that it can be thrown into gear with a friction drum on the axle, and set in motion, thus winding up the brake chain and checking the car.

A street car motor made on the Eickenmeyer model embodies the features of both the gearless and the reduction gear motors in a combined motor and truck. The truck form of armature is used, having 74 coils, which are wound on an arbor, from which they are removed and dried and insulated, then placed in position so that, if one becomes damaged, it may be removed and replaced without interfering with the

other or with the other's work. The armature is supported midway between the two axles and has its shaft connected by ordinary connecting rods with crank pins to both axles, the connecting rods being attached to both ends of the armature shaft and the crank set at 90° to prevent the armatures getting on the dead center, and to give a maximum starting torque in all positions. A 26-inch car wheel is used, as it is not necessary to raise the motor so far above the road bed. The motor is inclosed in an ironclad casing. The rheostats are in boxes over the axle, and the controlling mechanism, connected by shafts running the entire length of the car, may be operated from either end. The sills of the car body rest on four iron brackets placed on the motor castings, and on beams that extend across each end of the truck.

In the Dahl slow-speed railway motor the armature is directly upon the axle, being of the ring type and of large diameter, and attached to a non-magnetic spider which is placed on the shaft and is free to turn about it. Attached to this at one end is half a friction clutch, the other side of which is attached to the axle by a coiled spring. On each side of the web of the spider are two magnetic spools and cores, through the latter of which the hub of the spider is free to turn. Constant poles are formed by these magnets on the interior and exterior of the armature alternating in position, these magnets on the outside being brought together and held in position by dowel pins and a yoke bolted rigidly to them. This yoke is fastened to the frame or truck to keep the field magnets from rotating. The clutch consists of sheet iron

disks, each alternate one being fastened at the center or at its periphery. Those fastened at the center are attached to the ends of the spider; those fastened at the periphery are joined to the spring. The pull on the clutch causes it to slip, and the armature rotates faster than the axle. The armature may be kept rotating continuously. The weight of the 15-horse power motor is 1690 pounds.

The Thomson-Houston people have brought out a railway motor which is of the two-pole type, being so arranged on the theory that the comparatively slight gain in weight efficiency that could be obtained with a multipolar type is more than offset by the increased complication in winding. The only portions of the machine that are open to the outer air are exposed at two oval openings at the ends of the armature shaft; and these may be covered if desirable. The whole magnetic circuit is composed of two castings bolted together and free to swing apart by a hinge, allowing ready access to the armature. The armature is about 20 inches in diameter; a very powerful Pacinotti ring nearly six inches on the face and about the same depth, wound with comparatively coarse wire in 64 sections with 14 turns to the section. Each coil is tightly placed in the space between two of the projecting teeth, and about the interior space the separate coils are tightly packed, leaving only sufficient room for the four-arm driving spider. The armature takes up nearly the full height of the machine, the pole pieces being but trifling projections; the requisite cross-section of iron being obtained by extending the poles to form a

closely fitting iron box. There is but a single magnetizing coil, wound, not directly about the upper pole piece, but on the casing metal surrounding it. The lower pole is but slightly raised, and both pole-pieces are of the greatest extent permissible. The use of the single magnetizing coil produces an unbalanced field and an upward pull on the bearings, tending to remove the pressure on the bearings.

The gearless electric railway motor brought out by the Short Company has some very remarkable features. It is complete in itself, not being keyed to the car axle, nor touching it in any point. There are eight field magnets, four each side of the armature, arranged somewhat as in the Brush dynamo, and facing each other at a distance of only 10 inches. They are bolted to the framework of the motor, in the center of which are the bearings which carry the hollow armature shaft. Double arms, running out from the framework to the cross girders on the truck, make provision for the supports of the entire motor. The insulation between these brackets and the girders is provided by heavy rubber bushings through which the belts pass. The armature is keyed to a hollow steel shaft, concentric with the truck axle, and having an inch clearance all around it. The armature proper consists of a laminated iron core upon which are mounted separate and entirely independent coils, which may be separately rewound in case of accident. Mounted upon the hollow shaft, close to the armature is the commutator, which is protected from injury by the surrounding pole-pieces and is massive in construction. On the end of the hollow shaft are two

disks, the peripheries of which are insulated from the hubs by a wooden construction. Between the commutator and the disk on the one side, and the armature and a second disk on the other, are the bearings, which are carried by the motor frame. A three-armed spider is on each bed of the hollow shaft, each arm being provided at its end with a socket to receive a rubber cushion or spring; these cushions bearing upon lugs cast on the car wheel, and, as the armature shaft and spider turn, the action is transferred to the car axle. The rubber cushion insulates and causes easy starting, and has replaced the metallic spiral springs of the earlier forms of the motor. At a speed of 12 miles per hour, with a 36-inch wheel, the armature makes 94 turns per minute. The average voltage is 480, ampères 24, electrical horse power 15.44, average number of passengers 48.

The Short Company has also placed on the market a single-reduction gear motor known as the "water tight," dispensing with one pinion and one gear, and the remaining gear being run in oil. It uses a large Gramme armature.

In both these motors, by loosening four bolts in the frame and taking off the iron strips below, the wheel boxes and car having gearless motors may be jacked up, and the axle wheels and armature complete run out from under the car. The armature coils may be re-wound without removing the armature from the axle, and field coils may be quite easily repaired. The commutator may be reached and cared for with ease while the machine is running. The car may be run over a pit and every part of the motor reached without difficulty. The armature

weighs only eight pounds and may be taken out by two men in eight minutes.

The Short railway dynamo generator has a heavy frame to which are bolted light field magnets carrying shunt and series coils, and having pole pieces with side presentation to the armature, the magnetic gap being narrow and of large diameter. Within this rotates a shaft upon which is keyed a spider carrying a foundation ring upon which the armature is built up. The armature core is of thin sheet iron, wound spirally on the foundation ring and riveted together. The outside circumference of the ring is wider than the rest, and this part is milled out into notches, forming a modified Pacinotti ring. The coils are wound on a core around the hollow ring, so that each of the 200 coils is exposed to the air on all sides. At the commutator box is an adjustable bar bearing a thrust collar which receives the armature thrust in either direction. The commutator has 200 bars and a diameter of 20 inches. There are brushes carried by two independent collars and sets of brush holders. Multiple carbon brushes are used. The field coil terminals are carried to two heavy bars held securely in place, each side of the machine base.

A loose-wheel electric truck has wheels 36 inches in diameter loose upon the axle, and fitted inside the hub with roller bearings carried on a four and one-half inch journal. On the inside of each wheel is bolted a 20-inch gear, fitting into a pinion eight inches in diameter, keyed to each end of the armature shaft. This applies power to four points and gives traction

on all wheels. The entire weight of the motor is supported by two rigid axles, thus overcoming the friction caused by the motor bearing upon a rotating axle. The truck is interchangeable and will swivel under either an open or a closed car, and will take any radius of curve without interfering with the car sills.

An equalizing electric motor truck has a cross equalizing bar across one end, by which there is effected a three-point suspension of the car body, a double spring being in front of and a single spring at the side and rear of the front wheels. The entire truck may be lifted from either or both axles by removing a bolt under the end of the axle.

In a new motor truck by Goss the armature shaft runs lengthwise of the car and has two gears of corresponding different diameters, with friction clutches on the shaft parallel to the armature shaft, on each end of which are beveled gears meshing into gears on the axle. On each end of the gear is a controlling stand with three handles, the upper of which controls the speed of the car by a rheostat, the middle one being the reversing lever and the lower one connecting to the two clutches. This lower lever gives opportunity to get either power or speed.

THE THOMSON-HOUSTON FREIGHT LOCOMOTIVE.

The first electric freight locomotive built in this country has been made by the Thomson-Houston Electric Co., to pull freight 1¼ miles at Whitinsville, Mass. It is equipped with a motor, of the Thomson-Houston "C" type.

The power is communicated from the armature to the rear axle by double reduction gearing, and from the rear to the forward axle by parallel rods.

The locomotive is square, with a platform for carrying loads, and cowcatchers and draw bars at each end. The power is conveyed over a trolley wire, from which it is taken by a universal trolley bar. The total weight of the locomotive is 43,000 pounds, and the speed, when delivering 100 horse power at the draw bar, is about five miles per hour—sufficient to pull six to eight heavily-loaded freight cars on a level.

The motor consists of wrought iron field magnets, bolted to the magnetic yokes of cast wrought iron. One of these yokes carries the bearings which support that end of the motor on the axle, while the other yoke is spring-supported from the other axle. This keeps the gears in line and correct mesh, and provides spring support for the motor.

The gearing consists of aluminium bronze pinions and cast wrought iron gear wheels, and runs in gear cases containing a supply of grease.

On the intermediate shaft is heavily keyed a cast wrought iron brake-drum, covered with wood lagging. It is embraced by two half bands of steel, tightened upon it by the brake-drum lever, in the operating stand.

The driving wheels are 42 inches in diameter and are steel-tired, the frame consists of two side plates in which are located the main axle bearings.

Two cast iron end-plates, on which are cast the cowcatchers, are bolted to the side plates by through bolts, and carry the spring draw-bars and bumpers.

The operating platform is at one end of the main

platform, and is encased in a railing and covered with a protecting roof. On it are the levers for operating the controlling mechanism, the brake, and sand boxes; the universal trolley bar also extends upward from the locomotive at this place.

The controlling mechanism consists of two large rheostats of the Thomson-Houston railway type, so arranged with their contact shoes that no reversing switch is needed. The operator faces in the direction in which the locomotive is to go, and pushes the rheostat lever from him to make the locomotive go forward, and *vice versâ*. A positive center lock is provided so that, in turning off the current, there is no danger of passing the neutral point on the rheostats, and so reversing the locomotive with the current on. The operator always pushes the brake lever from him to apply the brake.

The bands are so arranged on the brake drum that the friction tends to tighten them up more upon the wood lagging, and so assists the operator in braking the train.

A combined main switch, lightning arrester and fuse box is within easy reach of the man, so that he can instantly shut the current off by a movement of the hand.

The motor is waterproof, the field spools having their wire inclosed and entirely sewed up in canvas bags, covered with waterproof paint.

Some data on the locomotive are given below:

Voltage of locomotive	500 volts
Power	100 horse
Speed on level track when developing above power	5 miles per hr.

Wheel base	6′ 4″
Wheel diameter	42″
Speed reduction between armature and axle	25 to 1
Gage	4′ 8½″
Height above rail platform	4′ 4″
Greatest length (at cowcatcher)	15′ 9½″
Greatest length of platform	12′ 7½″
Greatest width of platform	7′ ½″
Approximate weight of motor	5400 lbs.
Band brake on brake drum on intermediate shaft.	

The designing, building, and testing of this machine have been done under the supervision of J. P. B. Fiske, of the Lynn factory.

OTHER NEW ELECTRIC MOTORS.

A motor, which operates automatically at any desired speed or torque and with maximum efficiency under all conditions, is said to have been brought out by Leonard, who proposes the operation of electric motors under a new law, varying the voltage as the speed desired and varying the ampères as the torque desired; making the speed depend on the voltage only, independent of the current, and the torque depend on the current only, independent of the voltage. This law may be followed by supplying the field of the motor from one source of electric energy and the armature from another, the E. M. F. of which may be varied. When the speed is fixed a fixed voltage will be necessary to conform to the law; and the shunt motor will conform to the law. There will be a generator and a motor of the same size, their armatures being connected by two conductors. Their fields will be

supplied from a small separate exciter in the shape of a shunt-wound dynamo, and the circuit leading to the field of the generator there will be a rheostat. If the generator is driven at a constant speed its E. M. F. will depend upon the field, which in turn will depend upon the amount of resistance in the rheostat in its field circuit. The strength of the motor field will be constant, being supplied by the constant E. M. F. exciter. The speed of the motor will depend on the E. M. F. supplied to its brushes, and that can be varied from zero to the maximum limit by varying the rheostat, which will preferably be placed beside the motor itself. The current will automatically vary in proportion to the torque; the speed will vary directly as the voltage, and the efficiency will be constant and independent of the speed or of the torque.

To operate an elevator from central station conductors of constant E. M. F., there will be a shunt-wound motor mechanically connected directly with a generator, the armature of which will be connected to the armature of the elevator motor. The field of the generator will be supplied from the central station conductors, but a loop will go up to the elevator car, where a rheostat and reversing switch will be placed, so that the E. M. F. of the generator can be varied and reversed at will.

A mining motor intended to work in an explosive atmosphere is designed by Goolden, the whole armature and brushes being inclosed in air-tight and dirt-tight coverings, which are sufficient to exclude the explosive mixture for many hours; and it is claimed

that before such mixture finds its way into the neighborhood of the armature or brushes, the condition of the atmosphere will have been noted by the attendant and the current cut off. It is said that the inclosed condition of the motor does not interfere with the necessary amount of ventilation to keep things cool.

In a new governor for an arc motor a centrifugal governor attached to the armature causes any increase of speed to open the field magnetizing coils and to complete the circuit through the armature. With such a governor the motor will consume current only in proportion to the load. A further advantage claimed is that, by simply turning a hard rubber button, the speed may be adjusted to 500 turns per minute faster or slower than the regulation speed.

A differential gear for electric elevators has a wheel which carries journal bushings for two little shafts, each one holding two sprocket pinions tightly keyed upon them. These pinions are connected with two sprocket wheels through four chains; one of the wheels is firmly fixed to the foundation and the other keyed to the drum shaft. The driving shaft is supported by two bearings, one of which is formed by the drum shaft. As the armature of the motor turns around once, the sprocket wheel travels over as many links of the chain as there are sprockets on the large wheel.

APPLICATIONS OF ELECTRIC MOTORS.

A railway bridge at Rush Street, Chicago, is operated by an electric motor. The draw span is 240 feet by 59, with a 48-foot turn table, and weighs 800 tons.

The current is taken from the lighting company's mains. A 25-horse power motor is used, and the current is of 500 volts; and the normal current used by the motor is 35 ampères in turning the span. The old steam arrangement may be thrown in, if desired, in about three minutes.

A combination, tried in Chicago, driving a steam pump by a water motor coupled directly to a Thomson-Houston dynamo, is said to have given economy of fuel. The advantages claimed for this arrangement are that the system may be employed in pumping water during the day and for light at night.

Electricity is now used to drive portable drill presses, the motor being about four-tenths horse power for drilling holes up to one inch diameter in steel plates. The weight of the machine is 77 pounds. With four of these machines, the 60,000 holes in the protective deck of the Greek cruiser *Hydra* were drilled in sixty days.

In the adaptation of electrical power to working drills, as in iron ship building, Sautter, Harle & Co. have elaborated a system of conductors, formed chiefly of bands of copper fixed to wooden supports laid along the whole length of the vessel; drums large enough to carry a certain length of conductor are fixed to supports furnished with two contacts, which bear upon the copper strips, and so establish the circuit. In the general case of overhead distribution, or in the special instances of canalization for vessels, twin conductors 30 to 40 feet long end in a concrete

block inserted into one or two openings, made in a regulating rheostat ; in the other opening is placed a connecting plug fixed to one of the ends of a double conductor, 15 to 20 feet long; the other ends of this conductor being attached to the drill terminals. By rheostat the necessary difference of potential at the drill terminals, which varies according to the work, may be regulated ; and the current in the electro-motor may be reduced when the tool is rotating, without doing any work. A portable rheostat of variable resistance, with a multiple commutator, permits the workman to start or stop the motor, and within certain limits to regulate the speed of the cutting tool.

A drill 1.1 inch in diameter, working in soft steel, and having 704 down to 528 pounds pressure upon it, according to whether it was dull or sharp, took from four to nine minutes to drill soft steel to a depth of 1.02 inches; the voltage being 65 to 68, and the current in ampères 10.

Electricity for working pile-drivers has been attracting some attention. Near Paris there was a mill which had an electric light plant that lay idle during the day, and which was put to work a motor, raising a 1100-pound ram 16 to 20 feet. A current of 63 ampères and 100 volts was used, and the generator was about 330 feet distant. The conductor was a copper wire 0.2 inch in diameter.

A static electric motor, devised by Wimshurst, consists simply of a glass disk mounted upon a vertical spindle, and bearing on one face a number

of vertical sectors. The upper face of the disk is attached at two places by brushes connected to the poles of an influence machine ; and at right angles to these brushes there are two others connected by an equalizing rod. Under the rotating disk there is one which is stationary, having upon it two tin-foil sectors of about 90 degrees, which are in connection with the influence machine poles. When the influence machine is turned, the glass disk rotates ; or it may be made to turn by presenting the knob of a Leyden jar to one of the motor poles.

ELECTRIC MINING MACHINERY.

In electric mining machinery a paper by Llewelyn B. and Claude W. Atkinson, read before the British Association of Civil Engineers, goes to show that electric power is destined to become an important factor in mining mechanics on account of :

(1) The facility with which it can be used with machines which require to be moved about from time to time.

(2) The great economy in first cost and reduced cost of working, owing to its efficiency being higher than that of compressed air or any other medium of power transmission.

(3) The smaller cost of maintaining the cables as compared with piping, on shifting floors, in roadways, etc.

The methods described by the authors of the paper were sufficient to obviate all objections to the use of electric motors in coal mining, whether by excluding inflammable gases or by constructions which will allow all other safe combustion.

Experiments, trials, and practical work, extending over four years, show that :

(1) Electrical pumps may be used with advantage and economy for mine draining ;

(2) Electrical coal cutters can replace hand labor with saving in cost and increased production of coal ;

(3) Electrical drilling machines are valuable in place of machinery worked by hand or by compressed air.

An electric mining drill at Aspen, Col., is driven by a three-horse power Thomson-Houston motor, and in granite bores two inches per minute. In actual work in the mine it has averaged 1½ to 2 inches per minute. It bored 4400 feet at an expense of 68 cents per foot.

A solenoid coal-cutting machine has been made to enable undercutting with a machine concentrating its power upon a single reciprocating shaft carrying a chisel at its end. The apparatus weighs about 700 pounds and makes from 300 to 350 strokes per minute, of five to six and one-half inches in length. The machine is mounted on wheels at about its balancing point, so that it is readily directed.

ELECTRICAL TRANSMISSION OF POWER.

The Oerlikon Works are to be driven from a distance of 15 miles by an alternating current system, on the three-wire system.

Three hundred horse power, got from the River Neckar, were delivered at the Frankfort Exhibition, 108

miles distant, in the form of electrical energy, and with a loss of about 25 per cent. The first dynamo makes a combination of alternating currents, which are transformed into one of high pressure and carried through three bare copper wires, of not more than four mm. (about one-sixth of an inch) diameter, which are strung on ordinary telegraph poles.

At Frankfort a successful test was made carrying power from Lauffen, with 27,000 volts difference of potential.

Electric currents are now supplied to customers in London by the London Electric Supply Corporation, from Deptford. The pressure is 10,000 volts from there to the Grosvenor substation, and thence 100 volts. The trunk mains and substation transformers have been tested to 17,000 volts.

There is an electric power installation in the village of Oyonnax (Ain), using the water power of Charmines, seven kilometers distant. The fall is 54 meters and the available power 1750 horse. There is a force of 135,000 watts to be distributed among the lines and motors, and there are two secondary generators, each of which can furnish 80,000 watts at 1000 volts. These machines, which have an efficiency of 92 per cent., absorb 118 horse power each. They are driven by two receiving dynamos, the efficiency of which is 92 per cent., and which absorb 94,400 watts each. The loss in the line is 10 per cent., so that the primary generators have to furnish a current of 209,777 watts. The generators have an efficiency of 92 per cent., and absorb 310 horse power.

The establishment at Charmines has three turbines with horizontal axes, each driving a dynamo by direct connection, one of the group serving as a reserve.

The turbines have governors regulating their speed to two per cent. Their efficiency is 75 per cent. The two generators are coupled in tension, and each furnishes a current of 51 ampères at 2000 volts. The line, which is aërial, is calculated for a current of 51 ampères at 4000 volts, with a loss of ten per cent.

The loss per kilometer is 27 volts, and the diameter of the end conductors is 6½ mm. and of the entire conductor 4½ mm.

Messrs. Cuenod, Sautter & Co., have arranged an electric transmission to Oyonnax, concerning which we have the following details: The waterfall, that of the Oigrim, an affluent of the Ain, is of 54 meters, and the available power, 1750 horse.

The generating station is in two groups, formed of a turbine with horizontal axes, coupled directly to a Thury dynamo of 150 horse, furnishing at 350 turns a current of 105,000 watts at a tension of 2000 volts. The two generators are coupled in tension.

The line is 8 kilometers long and is made of three wires, two of 1½ mm. and one of ½ mm. The loss is figured at ten per cent. At the receiving station there are two receiving machines of 120 horse power coupled in tension, and getting a current of 1800 volts. They act by direct connection upon two secondary generators which furnish 600 ampères at 125 volts. The current supplies the village of Oyonnax by a three-wire circuit. The total duty is 76.2 per cent.

DIRECT PRODUCTION OF ELECTRICITY.

Edison's electric furnace is to have carbon or carbonaceous material for the generating or soluble electrode of a generating cell, there being used with it as an active agent, oxides, salts, or compounds of elements by the decomposition of which the carbon or carbonaceous material will be acted upon at high temperature. The cell is constructed and adopted for the application of heat externally thereto, and the conducting or ignition electrode of the cell is made of a substance which in the presence of carbon at high temperatures is not attacked to any great extent by the active agent employed. A fusible oxide may be used, as oxide of lead, and a flux may or may not be added, according as the melting point of the oxide is high or low. In the simple form there is a cylinder of carbon resting on a fire clay block, and contained in an iron vessel with a fire clay cover, the space between the iron pot and the carbon containing the active agent.

PRIMARY BATTERIES.

A new primary battery by McMillan has for a negative element a carbon plate placed in a porous cell, and the positive element is a zinc plate outside the same cell. The porous cell and the elements are within an outer containing jar. In the carbon plate are slots within which a depolarizer in cakes or plates may be arranged so as to virtually form part of the plate. The material preferred is manganese dioxide. The space between the carbon plate and the walls of the porous cell is nearly filled with small pieces of carbon, upon the upper surface of which a sealing material,

having vents, is placed. The electro-motive force of the cell is quoted as 1.4 volts, the internal resistance 0.3 ohm, giving 4.77 ampères on short circuit. After being short-circuited five minutes the electro-motive force was 1.2 volts and after 15 minutes one volt. After being allowed to rest a minute the cell gave 1.1 volts on closing the circuit. When short-circuited for six hours the electro-motive force was reduced to 0.7 volt, but after resting 16 hours the former electro-motive force was almost recovered.

During the past year three cars on the N. Y. & N. E. R. R. were fitted out with a plant for lighting them by primary batteries; 10 to 12 lamps of 16 candles each being used for each ordinary car and 22 in the directors' car. The private car carries an equipment of 120 primary cells for a long run; each set of 60 cells supplying half the line. The lamps require 106 volts at their terminals to bring them to 16 candle power. The cells are arranged so that they may be put in circuit in various manners so as to alter the voltage and the candle power of the lamps. Cells are beneath the car in a compartment large enough to contain the 60 cells, each of which is six by six by eight inches. The cells are in ten trays of six cells each. They are of zinc and carbon, the zinc weighing two and one-half pounds, and the carbon being in several small rods about the porous cup. It is claimed that 35 hours' continuous lighting may be had from the cells before changing of the liquid is necessary.

M. Trouvé has shown to the French Academy of Sciences the design of a boat propelled by a sea-water

battery. The plates of zinc and copper are placed under the boat like a keel, and the current drives a motor attached to a large wheel. The plates may be lowered or raised as required. Thomas Davenport, a Vermont blacksmith, made a similar suggestion, or design, fifty years ago.

STORAGE BATTERIES.

A new storage battery has light hollow plates molded in one piece and braced against buckling. The plate is open at the ends to permit the insertion of pencils or bars of active material, which are made under hydraulic pressure; then the ends of the plates are turned up. The separation and support is by a rubber grate one-eighth inch wide at top, beveling to three-eighths inch at the base.

L. James has brought out an accumulator having for positive plates lead alloyed with one per cent. of cadmium, and for the negative, lead with two per cent. of antimony. The plates have in them circular holes in which is placed the active material, which for the positive plates is 8.5 parts of minium, one of litharge, 0.40 of carded asbestos, and 0.1 of powdered carbon. That for the negative plates is 9.40 parts of litharge, 0.10 of sulphur, 0.40 of asbestos, and 0.10 of powdered carbon.

The Waddell-Entz storage battery is of the alkaline type, having for its two metallic elements copper and zinc, and for the electrolyte caustic potash. The zinc is deposited on iron electrodes, while the

copper is very porous and capable of ready oxidation. The solution of the cell is really zincate of iron. The action on charging is to deposit metallic zinc on the iron electrode, which latter is usually in the form of a tinned gauze, and the oxides the porous copper. On closed circuit the zinc is dissolved with the formation of potassium zincate and the oxide of copper is reduced. The porous partition is placed between the two elements, ordinarily made of parchment paper. The electromotive force of such a couple is eight to to nine volts. The porous copper has a permanent backing of dust copper that is entirely unaffected in the action of the cell and keeps up the conductivity. There is a dense copper coil surrounded by very porous copper, wholly enclosed in a textile covering. The battery weighs only 55 to 60 pounds per horse power hour stored.

Six accumulator cars are running from The Hague to Scheveningen, three miles, making 12 miles per hour, including stops. Each loaded car weighs 16 tons, being 32 feet long, carrying 68 passengers, the battery of accumulators weighing four tons. The cars have two swinging trucks of two axles each, only one truck being driven, and its wheels being coupled together. The axles are connected to the motor by solid gearing, and the whole weight is carried by the axles. The motor is supplied by carbon brushes from a battery of 192 Julien accumulators weighing 40 pounds each, and which when charged provide current for 45 miles. The accumulators are in eight boxes or drawers weighing half a ton each under the seats. There are switches and resistances to vary the speed.

Storage batteries have been compared by Gisbert Kapp of London with other sources of power, with this conclusion : that coal can be carried 1300 miles by rail by the consumption of ten per cent. of the energy stored in it, while accumulators can be carried only 26 miles. A load of 3¼ tons of passengers requires 2¼ tons of batteries to move it. In practice it is found that the entire charge of the storage battery is expended in from 30 to 60 miles. In Philadelphia a car weighing 10 tons requires at times a power of 17 horses, and a mean expenditure of 5.6 horse power.

An English inventor believes that he can run clocks by natural electricity from the earth. The earth's currents vary considerably, but by an automatic arrangement fixed by the pendulum, he can keep time, he asserts, to within one minute in a year.

ELECTRIC MEASURING.

In a new electric meter by Perry the principle is to use an electro-motor, and let its motion be retarded by forces proportionate to the velocity, such forces being fluid friction when the motion is very slow, and resistance due to Foucault or eddy currents. This requires excellent pivoting and the avoidance of all solid friction of brushes or rubbing contacts. The armature is a cylindric copper vessel, closed at its upper end except for a few holes. It is like an inverted claret glass, and is immersed in mercury, in which it rotates ; receiving current from a heavy ring of copper, the current passing through the mercury to the lower edge of the armature, passing in a cylindric sheet upward through the armature, to

a fixed tube dipping in the mercury. The armature is coated with varnish everywhere except where it receives and gives off current, at which places it is nickel-plated. A phosphor-bronze spindle gives motion to the counting arrangement, and is in two pieces, so that the upper part may be insulated. An imperfectly constructed instrument started up with 0.2 ampère, from which place to 100 ampères there was but one point, 10 ampères, at which the error was as great as one per cent. There is nothing to alter with time, and the temperature errors balanced themselves.

The Frères propose a recording electric meter which measures the current every 15 seconds and registers the reading, producing a total which may be read off as kilowatt hours.

A statoscope has been produced by the Frères, for use with their recording electric meter, so sensitive that it showed if it were lifted from the floor to the table, and *vice versâ*.

The Teague electricity meter, made by the Acme Electric Works, of London, consists of an electric motor of simplest form, its armature consisting of a hollow cylinder of non-magnetic metal, placed in an intense magnetic field formed by boring a hole in the end of one pole piece of the magnet and letting the opposite pole piece extend through the hole. The current is led to and from the armature by two mercury contact troughs, one of which is connected to the spindle, and the other to the lower edge of the

armature. The armature is geared to a train of wheels carrying pointers; and the result is read in Board of Trade units without constants or multipliers.

A new watt-meter brought out by Swinburn is for doing away with the trouble with ordinary watt-meters with alternating currents, that if the pressure and current are not stopped, as is the case when an alternate pressure is applied to a resistance, such a meter reads too low; but if a pressure is applied to an inductive current, the reading may be high. In the new meter the moving coil has but few turns, and these are wound on a light mica former. The coil is held by top and bottom stretched wires. External resistances are supplied, being wound with the alternate layers right and left handed, so that the time constant of the fine wire circuit is made sensibly equal to zero. Readings are taken by a torsion head in the usual way, but if measurements of minute powers such as hundredths of a watt, a mirror is used.

A pressure indicator consists of a solenoid, through which moves an armature, controlled by the attraction of the solenoid, opposed by gravity. It is so arranged with a circuit-closing device that when the E. M. F. rises above the standard at which the instrument is set, a red danger-lamp burns; if the E. M. F. falls below the standard, a green lamp is lighted. A hard rubber plate carrying the solenoid and circuit closer is made to rotate upon the base, so that the instrument may be set for any E. M. F. with a standard volt-meter.

CURRENT TRANSFORMER.

In the Lehmeyer current transformer the high tension current flows to the armature coil, wound upon the main armature, while the secondary coil, besides surrounding the main armature, also passes around the larger armature. Acting on this latter there is a field magnet upon which circulates the secondary main current. The current in this coil is proportionate to the difference of current of the main or larger armature ; the additional electro-motive force of the secondary or smaller armature is also proportionate to it. The compound magnetic field is separated from the main field by brass insulation. The secondary armature and the field magnet belonging to it are thus separated from the main magnet. Compared with motor dynamos a transformer of this construction has the advantage of reduced size and cost.

AUTOMATIC CURRENT REGULATOR.

The Tomlinson automatic regulator for electric lighting by alternating currents is arranged to do away with the trouble of having all the transformers of a system in the circuit all of the twenty-four hours. The transformers are arranged in five groups, each one containing double the number in the group before it. They are thrown in or out by a switch moved by weights, which are wound up once a week. There is a double relay in the secondary circuit of the fixed transformers. When the current exceeds full load a contact is made, and a small current sent through a magnet on the apparatus along a wire to the central station, where it passes through a chok-

ing coil to a bell. The attendant then puts down a switch, which short-circuits the choking coil to the bell, and allows enough current to pass to actuate a magnet controlling the mechanism in the apparatus and put in a sufficient number of switches. The magnet for taking out transformers is worked in a similar way by the other part of the relay, which acts when the current in the fixed transformers falls to less than half load.

LIGHTNING GUARD.

In a new lightning guard for electric light installations the current enters at one end of the axis, circulates through two highly-insulated thick wire coils, and leaves by the other end of the axis; but in so doing it has passed three pairs of brass collars which clamp between them a square of mica coated with tin foil, the corners of which come very near to an outer metal case connected with the ground. When lightning attempts to follow the circuit, it splits off from one or the other of the corners of the first tin foil to earth, thereby striking a momentary arc, which is destroyed the next instant by the fusion of that corner of the tin foil. The other corners are ready for a future occasion. The air gap inserted between the brass collars and the outer case must depend on the voltage of the installations and length of the arc expected.

PROTECTOR FOR ELECTRIC APPARATUS.

In a new protector for telephone and other electro-receptive instruments, the main feature is the manner in which the fuse is melted by the generation of heat in a small coil of comparatively high resistance

wire, which is wound upon one end of the fuse and which is part of the circuit. The coil is of German silver wire, of sufficient size and length to produce heat enough to melt the fuse upon the passage of any current at which it may be deemed desirable to have the line. For ordinary use at subscribers' stations they are wound to open the line at 0.4 ampère. The device is a protection against the "sneak" current so destructive to electrical apparatus containing electro-magnetic coils of fine wire, as well as against heavy or abnormal currents.

SAFETY DEVICE FOR ELECTRIC WIRES.

A safety device for electric wires has at the end of the wire a plate which is inserted in a slide at the end of wire from the tie or supporting wire which is slotted to receive it, thus forming the connection and holding it in position unless the wire should break. In this case springs would draw this plate out and away from the other, allowing the trolley wire to drop down, thus breaking the connection and rendering the broken wire perfectly harmless until it is repaired.

ARC LIGHT CUT-OUT.

In a new arc light cut-out the circuit is always closed about the lamp before it is dropped from the hood, thus avoiding the possibility of an open circuit. The cords for raising and lowering the lamp are relieved of weight when the latter is in position. Both current and sustaining wires lead to the top of the hood, the danger and unsightliness of swinging wires is overcome, the lamps may be lowered safely

among other wires, and the cut-out is said to be sleet-proof.

MICA INSULATION FOR WIRES.

A mica insulation suitable for all sizes of wire has been produced. It consists of three leaves, the two outer ones being of paper and the inner one a very thin film of mica. The material is prepared in large sheets, then cut into ribbons and wound upon spools which are placed upon a specially-designed machine, which wraps the wire with the insulation as quickly as could be done with cotton thread. The wire may be afterward coated with rubber if desired.

NEW INSULATION PIERCER.

An insulation-piercer has been brought out, permitting a covered wire to be pierced for the purpose of making contact. There is a clamp, and a screw ending in a sharp steel point. The hole left is so small that a pinch closes it up, and even the smallest wires are reached without danger of slipping or breaking.

NEW MODE OF HOUSE-WIRING.

A new system of house-wiring, brought out by the Interior Conduit and Insulation Company, consists in fitting the building with continuous tubes of insulating material, through which the wires are drawn. The tubes are of paper soaked in a 460° F. bath of bituminous material.

AUTOMATIC ELECTRIC VALVE.

An automatic electric valve for steam heating systems has a thermostat on the wall above the radiator and connected by three wires with a valve and with

an electric battery. When the temperature of the room rises above the degree for which the thermostat is set, a circuit is closed through the thermostat; electro-magnets are energized, and attract their armature, and a motor is started which closes the valve.

ELECTRIC TIME STAMP.

An electric time-stamp, the works of which take up less than two and one half by three inches, by three inches high, prints the year, month, day, hour, and minute clearly and distinctly in a space the size of a silver quarter. The machine automatically changes the months and hours and at midnight changes the day. It is operated by a simple pressure instead of by a blow. It may be operated on open or closed circuits by battery or by continuous or alternating electric light circuit; and is adapted to run on any signal or time circuit where the impulse is given once a minute.

ELECTRIC CAR HEATER.

An electric car heater consists of a thin plate of cast iron, two feet long, three inches wide, and one-eighth inch thick, to one side of which the resistance wires are attached, but insulated therefrom by an enamel coating, which prevents consumption by electrolysis of the resistance wires. This plate is fastened to the support of the car just back of the passengers' feet, and is surrounded by grate-work, protecting the clothing but not obstructing radiation.

An electrical cloth-cutting device has been invented by Weyburn, of Chicago. The cloth is cut by a

circular wheel, driven through a flexible shaft by an electric motor running along a guide rail over the cutting table.

ELECTRIC TELETHERMOMETER.

Chibout has devised a metallic thermometer that can transmit its readings to any distance. The transmitter is a very stiff bar of very expansive metal, fixed at one end of a marble support, the other connected with a lever to magnify the variations. To this lever is attached a second bar similar to the first, and the effects of each are added to the first bar, in order to be transmitted to another lever like the first. The connecting points of the bars and levers are flat steel springs inserted in the pieces to be connected, thus suppressing play and friction. A rack mounted upon the second lever gears with a pinion the axis of which carries a needle, which shows upon a dial the different variations due to the expansion of the bars. Upon the second lever is a needle with a contact which moves before a sector of thin copper plates, insulated from each other and reproducing the gradations of the needle-dial. There is a special circuit for each gradation, or rather a single circuit having its intensity for each gradation modified by a resistance coil. The receiver consists of a circular solenoid, in the center of which there is a movable axis carrying a needle and a small bar of soft iron, opposite which there is a stationary bar. Starting the current causes these bars to repel each other to a degree corresponding with the intensity of the current, which is proportioned to the degree of motion of the needle at the sending instrument.

ELECTRIC PYROMETER.

Collender has produced an electrical pyrometer in the form of a platinum resistance consisting of a fine wire welded to leads of comparatively low resistance. As the electrical resistance of this wire will vary with the temperature, the temperature may be measured by the resistance. It is said to be an improvement on Siemens' similar instrument, by reason of the greater purity of the metal and its better protection and treatment.

ELECTRIC PHOTOGRAPHIC TIMER.

An electric photographic timing device, for photo-engravers and others, is designed to automatically open and shut the lens tube of the camera, and to give such a length of exposure to the plates as is determined by the setting of a movable contact piece, on the periphery of a clock dial, at the number corresponding to a number of seconds required ; such contact lying in the path of a contact arm driven by clockwork. When the dial hand or arm comes in contact with the movable contact piece, the electric circuit is closed through a magnet arranged within the camera for operating the drop shutter.

NEW MAGNETO-BELL.

A novel magneto-bell has a Siemens armature mounted in the field of a permanent magnet, and carrying the bell hammer. The armature coil being traversed by alternating currents, successive reversals of polarity occur, causing the hammer to vibrate

vigorously through a wide angle. The efficiency of such a bell is apparent, as the armature poles are always near the field poles.

ELECTRIC SOLDERING IRON.

An electric soldering iron consists of a copper tip like those ordinarily used on soldering irons, and having a heating resistance of German silver wire coiled about the shanks that connect this tip with the handle. The tip and handle are fitted to screw on, the resistances are covered with a copper cylinder still further to lead the heat to the tip and to protect the wire from injury. The insulation is of mica and asbestos, so packed around the resistance coil as to prevent short-circuiting, and to insulate the coils both from each other and from the body of the iron.

ELECTRIC EXERCISING MACHINE.

An electric exercising machine has in a wooden case a small magneto machine, which is driven when the operator pulls on the handle which is attached to the box. The straps attached to the handles pass around pulleys on the magneto, and by suitable connections the current is passed into the body of the operator, who thus gets both physical exercise and electric stimulation.

ELECTROLYTIC COPPER PIPES.

The Elmore Copper Depositing Company at Leeds, England, is making pipes and cylinders of copper, and coating hydraulic rams with copper, by electrolysis. When it is desired to make a tube, an iron

mandrel the size of the tube bore is placed horizontally in a tank containing a solution of sulphate of copper in water, with a percentage of sulphuric acid. Before being placed in the bath, the mandrel receives a thin coat of copper by the ordinary cyanide process. The mandrel is caused to rotate in the bath by chain gear. It forms a cathode, while the anode consists of granulated copper spread on a perforated tray on the bottom of the bath. The burnishing is accomplished by an agate held in a suitable holder and pressed against the work by elastic bands, tracing a screw line on the tube. It takes one week to make a tube one-eighth inch thick, the rate being independent of the diameter. The current density averages 16 ampères per square foot of cathode surface. A 12 by 2-foot tank turns out one 18-inch tube per week of 168 hours, or 275 to 280 pounds of copper tube per week.

ELECTRICAL PURIFICATION OF WATER.

In the employment of electricity in the purification of water, hydrated oxide of lead is placed in a filter press traversed by the water to be purified, and precipitates all the carbonates, sulphates, and chlorides. To make the oxide of lead cheaply, a current of electricity is passed between lead electrodes of large surface plunged in a solution of sodium nitrate in water. Caustic soda is formed in the negative compartment, nitric acid at the positive pole, from which it dissolves a certain quantity of lead and forms lead nitrate. After a certain time, the two solutions are run into a vat where they are mixed ; the soda precipitates the hydrated oxide of lead, and itself forms

sodium nitrate; the liquid is then filtered, and the sodium nitrate solution which runs through the filter again subjected to electrolyzation.

ELECTRICAL IRON SMELTING.

In a new process of smelting iron by electricity the metal is placed in a cupola that has electrical connections, and a strong current passing through it forms arcs at each electrode and produces great heat, which melts the metal. The molten metal flows into a receptacle below the cupola, and is thence drawn off.

SILVERING IRON BY ELECTRICITY.

A new process for silvering iron consists in pickling the objects in hot dilute hydrochloric acid, then removing to a solution of mercury nitrate, and connecting with the zinc pole of a Bunsen element; gas-carbon or platinum serving as the other pole. It is rapidly covered with a film of mercury, when it is removed, washed, and put in a bath to be silvered. By heating to 300° C. (572° F.), the mercury is driven off and the silver firmly fixed to the iron. To save silver, the wire can be first covered with tin.

Groth, of London, has devised a process of tanning by electricity; a current of electricity from a dynamo passing through the skins as they are suspended in the tan liquor.

Electricity has been employed in improving the keeping properties of wine.

Electrotype copies of the dead may be made by painting the skin with a concentrated solution of nitrate of silver, reducing this with vapors of white phosphorus dissolved in sulphide of carbon, then putting in a bath.

A patent has been taken out in France for the electric incineration of human remains.

ELECTRIC KITES.

Experiments with electric kites, near Boston, have resulted in measuring the electric potentiality of the atmosphere at every step; measuring cloud heights, velocity of wind, etc. The average height of the nimbus clouds was found to be 412 meters, cumulus 1558, false cirrus 6500, cirro-stratus 9652, and cirrus 10,135. The average velocity for the cirrus was found to be, in this place, 82 miles an hour —twice that found at Upsala. The extreme velocity was 133 miles an hour. Below 500 meters the wind velocity was found to be less than cloud velocity; above that, excess of the cloud velocity increased up to 1000 meters, then decreased until 1700 meters, after which it steadily increased.

THE SCHISÉOPHONE.

The schiséophone is an apparatus invented by Captain de Place, of Paris, for detecting internal flaws in metal. It consists of a small metallic tapper, worked by hand, and connected with a telephone with a microphone interposed in circuit. By this means a flaw may not only be discovered but located.

THE FLUVIOGRAPH.

The fluviograph is a French instrument for recording, at any desired distance, by electricity, variations in the height of water level of a water course, and giving timely warning. It consists of a float about an inch in diameter, rising and falling in a vertical tube in communication with the stream. This float transmits its motion to a wheel, with one meter circumference, which gears with another of such proportions that every five centimeters of vertical displacement of the float corresponds to the interval of two teeth on the smaller wheel. An electric contact permits sending an electric current through a wire at every such displacement. This instrument is not new, but it is desirable to draw attention to it for American use.

A magnet for lifting pig iron from the pig bed, and made by the Thomson-Houston Motor Co., raises 7200 pounds. Is is like a bell, with nearly vertical sides, standing 20 inches high, and measuring 24 inches across the bottom.

ELECTRIC LOCOMOTIVE HEADLIGHTS.

The C. H. & D. R. R. Co. has in use on its line twelve electric headlights, concerning which its Superintendent of Motive Power says: "We have had several of these lights in use during the past two years, and to date have given us the most perfect satisfaction. Small objects can be discerned clearly during the night one mile ahead of the engine.

Obstructions on the track of any kind larger than a cat, bridges on fire, and things of this kind can readily be detected by the engineer in time to stop his train before reaching the obstruction. The cost of maintaining these lights is about one cent per light for the single carbon used. There is no question in my mind but that these lights are a very necessary article for the prevention of accidents of all kinds after night. This headlight is said to have about 2500 candle power and to show objects on the track from half a mile to 2½ miles distant. A water tank was sighted at a mile distant. The carbons last 18 hours and cost but 18 cents per hundred.

ELECTRIC SHIP LOG.

Granville's electric ship-log has no special battery; the log, the iron hull of the ship, and the ocean, forming one. A portion of the log is of zinc, which provides one element. The log is watertight. There are but two moving parts: a rotating head and a small internal worm wheel. The sea water has access to all working parts. The tow line is a braided tanned netting twine, inside of which there are copper wires wound spirally and joined at each end. It may be coiled and handled by any sailor just like any other line.

ELECTRIC THIEF DETECTOR.

The inventions for preventing thefts from show cases are numerous, and electricity is now being brought into use in connection therewith. A Minnesota man has in the bottom of his show case a number

of metallic strips, and the tray has spring clips for holding the articles to be exhibited, the clips being connected electrically and held open by the articles. The tray has contact points bearing on the metallic strips, which are in the circuit of a battery, and an alarm bell. When an article is removed from any one of the clips the contact points come together, close the circuit, and give an alarm. If an article be removed when the tray is out of the case the alarm is sounded when the tray is put back.

EFFECTS OF ELECTRICITY ON PLANT LIFE..

The results of the experiment in the agriculture station of Cornell University go to show that the influence of the electric arc lamp on greenhouse plants is to promote assimilation, hasten growth and maturity, produce natural flavors and colors in fruits, and even to intensify colors in flowers ; and sometimes to increase the production of flowers.

"The forcing house was divided by a board partition, one-half being subjected to natural conditions of light and darkness, and the other to sunlight by day and the light of a lamp of 2000-candle power during the whole, or part, of the night. Leaf plants, such as lettuce and spinach, ran to seed before edible leaves were formed, when the lamp burned all night. Plants near the lamp died soon after coming up. Of the entire crops those in the normal house were twice as great as those in the light compartment. The influence of the light on the productiveness and colors of flowers varied with different species and with different colors of flowers of the same species. When six varieties of tulips bloomed in the light compartment

their colors were deeper and richer, but the colors lost their intensity after a few days. They had longer stems and larger leaves. Verbenas growing near the lamp were injured, being stunted and with short-lived flowers. Scarlet, dark red, blue, and pink flowers within three feet of the lamp soon turned to a grayish white. Petunias grew taller and more slender, bloomed earlier and more profusely. Radishes were earlier, but smaller. Some of the experiments showed that injury followed the use of the light when the plantlet was losing its support from the seed, and that good results followed the use of it later."

The experiments show that plants do not need periods of darkness for rest. "There is every reason, therefore, to suppose that the electric light can be profitably used in the growing of plants"; and the further inference is "that if the electric light makes plants to assimilate during the night and does not interfere with growth, it must produce plants of great size and marked precocity."

Experiments in France go to show that a row of hemp subjected to the influence of the electric current, produced stalks 18 inches taller than those not electrified; 2.2 pounds of potatoes planted in the path of the current produced 21 times their weight of very large and healthy tubers, while the unelectrified patches gave only 12½ fold, of medium size tubers. Electrified tomatoes became ripe eight days before the others. Barat has found that if a quantity of manure is placed near the positive pole, its constituent parts are carried toward the negative pole, and their effects make themselves felt around a distance of some yards.

THE PORTELECTRIC SYSTEM.

The United States Portelectric Co. has been organized with the intention of furnishing portelectric transmission between New York and Brooklyn. The carrier is a hollow wrought iron cylinder with pointed ends, 12 inches in diameter and 12 cubic feet capacity, capable of carrying 20,000 letters. It is to be supported on a single rail, propelled by an electric current, passing through hollow helices of insulated copper wire every 10 feet. The wheels of the carrier automatically cut in circuit the helices just in front, and cut out all those back of it. Experiments on a track of this kind in Dorchester lead the projectors to claim a possible speed of 150 to 200 miles per hour.

ELECTRIC CARRIAGE.

A new electrical carriage, by Morrison, derives its motive power from 24 accumulator cells under the seats, the motor being on the rear axle. The winding of the motor is such that reversal of the current causes the carriage to run backward just as well as forward.

THE ALTERNATING CURRENT.

Siemens & Halske, of Berlin, invited the members of the Electro-technische Verein to an exhibition of 20,000-volt alternating currents. The tension was conducted through wires of only 0.2 mm. (.08 inch) diameter to a battery of 200 one-hundred-volt incandescent lamps connected in series. An ordinary Siemens electric light cable being inserted in the circuit, broke down at 15,000 volts.

Prof. Elihu Thomson has contributed a valuable note on the physiological effect of alternating currents of very high frequency, going to show that they are less dangerous than those at the lower rate now in vogue.

INTERESTING ELECTRIC HEAT MOTOR.

Bidwell has made a heat engine which depends for its action upon the fact that nickel is magnetic at ordinary temperatures, but not above 300° C. A slip of this metal is fastened to a disk of copper hung by two strings. On one side of the metals is a magnet with which the nickel is kept in contact. Heating the nickel with a lamp, it becomes non-magnetic and falls off, the pendulum making a swing. Passing through the air cools it, and it becomes again attractable by the magnet, and so on, as long as the source of heat is kept up.

OZONE MAKING BY ELECTRICITY.

The commercial manufacture of ozone by electricity has become quite common. The best known apparatus consists of an inner metal tube surrounded by an outer one. The top and the bottom of the metal tube are closed and the space between the covers filled with cooling water kept in circulation. Above the top and below the lower cover there are holes through which the gas to be treated is drawn from the upper space into the space between the dielectric cylinder wall and the inner metal tube. Thence it passes to the lower end and out. The dielectric cylinder is of hard rubber and celluloid. Continuous

currents interrupted by a special rotating commutator at 600 breaks per second has given better results than alternating currents having only 50 to 100 reversals per second. Up to 4000 volts, using a glass tube, no ozone is liberated. With two horse power, 2.4 milligrams of ozone may be produced per second.

PHOSPHORUS MAKING BY ELECTRICITY.

The manufacture of phosphorus by electricity by the Readman Parker process dispenses with the use of sulphuric acid for decomposing the phosphate of lime, and of fire clay retorts for distilling the dried mixture of phosphoric acid and carbon. The raw materials, carefully mixed, are put in the furnace and the electric current turned on, the vapors and gases from the furnace passing to large copper condensers, the first of which contains hot and the second cold water; finally passing into the air. As the phosphorus forms it distills from the mixture and the residue forms a liquid slag at the bottom of the furnace. Fresh phosphorus-yielding material is added at the top. The operation may be continued for days. The charges are native phosphates without any previous chemical treatment; the only addition being the carbon to effect their reduction. The crude phosphorus is tolerably pure and is readily refined in the ordinary way. The furnaces yield 1½ gross cwt. per day; the engines of the works will yield 1200 indicated horse power. The dynamo gives 400 units of electrical energy, equal to 536 indicated horse power.

ELECTRIC DENTISTRY.

Electricity has been tried successfully in London for tooth extraction. There is a Ruhmkorff coil with a commutator of extreme sensitiveness. One of the handles of the battery is connected with the negative pole ; the positive is divided into two, so that one of the divisions is connected with the handle, and a wire from the other is screwed into the handle of the tooth forceps. When the patient takes hold of the handle the current is gradually increased in intensity until he can bear no more ; then while the forceps are being introduced the current is turned off for a second, and on again. The rest is the same as without electricity. The patient experiences no pain. The theory is that electricity travels over the nerve at the rate of 420 vibrations per second, while pain travels from the tooth to the brain in $\frac{1}{60}$ second. The electricity gets to the brain first, and keeps the line for itself, crowding out the pain.

Dentists are said to have found that the electric light enables them to find cavities which were imperceptible by daylight ; particularly that form of caries known as white decay.

The long proposed system of stopping runaway horses by an electric current through the bit has been tried in Chicago, and, it is said, with success.

An electric welding machine, for making chain cables, has been produced ; two links being welded at once.

The electro-magnet is now used very considerably in high surgery, as for extracting chips of iron from the eyeball. In many cases it has proved the only means of preserving sight.

Electric wands are now used in bee-taming.

Prof. J. J. Thomson has made vacuum tubes without electrodes, but surrounded by coils of insulated conductors and connected with Leyden jar batteries. Whenever the jars are discharged through the surrounding conductors, the tubes glow with a color depending upon the gas with which they are filled.

The International Congress of Electricians at Frankfort, have recommended that the names of the electric units, ampère, coulomb, farad, joule and ohm, volt and watt be abbreviated by their initials.

Dewey proposes a floor or floor mat that can be electrically heated by a low tension current; being arranged if desired so that the feet will not touch the conductors.

TELEGRAPHY.

THE past year has added but little to the science of telegraphy, compared with what has been done for it by other years gone by; but there have been advances in the direction of multiple transmission, under circumstances hitherto considered unfavorable to their undertaking; and conveniences have been added, in the way of calls and answer boxes, and in

lightning arresters, etc., which have redeemed the year from any charge of having yielded unprofitably to intelligent research.

THE PHONOPORE.

The phonopore is an apparatus intended to serve as an adjunct means of telegraphing over a line already in use; and it permits an ordinary telegraph line to be duplexed, for the transmission of two messages in the same direction or in opposite directions. The system consists in sending rapidly vibrating induced currents over a telegraph line already in use, and then employing these currents to operate a special relay working an ordinary Morse or other receiver. So far as the vibratory currents are concerned, the line is completely insulated, the induction being produced by a special coil in a circuit containing a vibrator. The transmitter consists of a circuit containing (1) the phonopore; (2) a vibrating rod to produce the oscillations of current, and (3) a Morse key. The phonopore itself consists of a primary coil built up of a number of distinct coils connected in multiple arc, and all wound upon a sheet iron core; around this multiple helix is a pair of secondary coils insulated from each other, one end of each being insulated, the other being connected respectively to line and to earth. Depressing the key starts the reed vibrating, and causes on the line very rapid induced electrical oscillations, which, being of but small intensity, produce no effect on the ordinary telegraphic apparatus. The vibrating reed is tuned to a very high pitch, and forms a prolongation of the armature proper. At the receiving station there is a soft iron core, upon which are

two helices, one connected through the line with the transmitter, and the other being part of the local circuit, including a battery, galvanometer, and relay. The current also passes through a contact formed by a reed tuned to the same period as the transmitter, and another contact piece supported on a weaker vibrating spring of slow period. When the reed is at rest, the contact between it and the vibrating springs is closed, the local circuit magnetizes the core, and the reed is brought into equilibrium. If a pulsating current, having a period synchronous with that of the reed, comes in, the reed will be made to vibrate violently; this will cause it to strike contact pieces on a weak spring forming a part of the local circuit, thus breaking this circuit and throwing into action the relay, which, in turn, sends its signal to an ordinary telegraphic sounder. A single impulse, particularly if of period not the same as that of the reed, will not work the receiver. Experiments in England have given good results, over 100 miles of line, with a Morse printer, over a line that was doing a busy railway traffic.

A NEW TELEGRAPH CALL.

A new telegraph call has for its object the calling individual stations by a continuous ringing bell, that shall ring loudly enough to wake an operator without giving signals in any other office. It has not only an individual selector, but an automatic "answer back," which sends a return signal to the point of call; and a mechanical transmitter which enables any number of stations to be called quickly and reliably from a central point. The selector at every

station has a controlling wheel with its rim cut to a combination differing from that of every other selector on the line. The "answer back" has a wheel cut with the station signal and with such other letters as may be desired. At the train dispatcher's office a mechanical transmitter is inserted in the line, carrying as many disks as there are stations equipped with the locks; each disk being cut with the combination for a given one of the locks. The dispatcher inserts a plug in the transmitter at the disk desired and turns a crank; as the transmitter turns the signal is sent over the line with clear makes and breaks and selects its corresponding lock, which, taking up the combination, closes its local circuits and rings the gong. The "answer back" magnet is energized and returns over the line the signal indicating that the lock has made its combination, the local circuit has been closed, and the gong rung. This system permits of calling an operator, of throwing the station signal or semaphore if the operator fails to respond, and of cutting out any particular office or offices so that messages shall not be read by intermediate stations.

Telegraphers' feats in working on long circuits when short circuits have been broken was illustrated during the first days of the blizzard of three years ago, when news was sent from Boston to New York by way of an ocean cable, but the operation of long land circuits is not uncommon. An operator in Portland, Or., relates an experience on the longest land circuit probably ever operated. The wires on the Southern Pacific went down, and early in the evening all communications east of Omaha were shut off, but the Northern

Pacific wires were connected and Associated Press dispatches from the East were sent to Chicago, and thence to St. Paul, Helena, Portland, Seattle, Tacoma, San Francisco, and Los Angeles. The dispatches were repeated at relays automatically. The circuit extended from the extreme north to the extreme south, and from the Atlantic to the Pacific.

A telegraphic instrument recently devised by Samuel W. Smith, of New York City, consists of a key board like a typewriting machine, a depression of each key of which causes the regular Morse dots and dashes to be made.

In the great storm of January 25, there were many telegraphic wires broken. The Wheatstone duplex instrument during that time sent 30,000 words from New York to Chicago in one hour, thus doing the work of ten expert senders.

A telegraph between Pekin and St. Petersburg is decided upon.

There is to be a submarine cable between Pernambuco and Senegal.

The soundings made by Belknap in the North Pacific show that the great circle route for a submarine cable is not feasible, there being a trough or basin along the east coast of Japan and the Kurile Islands, and under the Japan stream, in one case having 4643 fathoms without bottom being reached. The depth of the deepest cast, 5¼ miles, is enough

to hold two mountains as high as Japan's Fusiyama, one on top of the other, and then the summit of the highest would be nearly two-thirds of a mile under water.

THE TELEPHONE.

It would at first seem that there were few new fields to cultivate in the line of telephony. During the past year the principal subject of discussion in this line has been the matter of the fundamental patents which control the invention ; but there still have been, if not great strides, at least very steady onward progress in this line ; notably one from the far Antipodes, to which the place of honor is accorded.

LONG DISTANCE TELEPHONY.

The Collier audible telephone employs a soft iron armature directly between the poles of the magnet, thus using two poles, and with these two vibrating diaphragms, one between each pole and the core ; and the sound of the vibration is taken from inside the diaphragm box instead of from outside as is now usually done—the latter arrangement giving greater volume of sound by reason of the greater activity of the magnetization and from the additional magnetic variations going on in the core. The sound will almost fill a small room, and it is said that the objection to the telephone in India, that the natives of one caste will not use the instrument placed against the ear of a native of a lower one, is now done away with. The core of soft iron, laminated both endwise and

lengthwise, is mounted on an insulating reel and wound with wire ; then mounted in a solid block of ebonite, having a ring turned out as usual to grip the metal diaphragm. On each side is a pole piece, the two forming the magnetic poles, each nearly touching the diaphragm. The magnet is placed outside the whole. From the inside surface of the two diaphragms three small holes are led up each side to the mouthpiece, which has a small cone to lead and concentrate the sound.

Bottomley, manager of the Telephone Company of Ireland, says that, from the experiments made, he is satisfied that conversation with this instrument, without the aid of a microphone, could be carried on with distinctness and comfort over a line of 5000 miles.

The telephone from London to Paris was laid early in March, and conversation goes on well. There are in the cable four separate conductors, two for each circuit ; each one being a strand of seven very pure copper wires, weighing 160 pounds per nautical mile. The English overland wire weighs 400 pounds to the mile, and the going and returning wires of each circuit are twisted spirally around each other, so as to exchange their places and thus prevent induction. This line is 85 miles long. The French overland wire is 204 miles long and weighs 600 pounds per mile.

This telephone is said by Preece to give most satisfactory results ; there being no circuit in or out of London on which speech is more perfect than between London and Paris. Speech has been extended to Brussels, and even to Marseilles, 900 miles.

During the past year, concerts given in New York were heard by an audience of 1000 people in Newton, Mass., 250 miles away. Similar entertainments have been given, in clear weather, with a distance of 460 miles between.

The republic of Costa Rica is soon to have a complete system of telephonic communication. The government has made a contract for the establishment of telephone service between all the towns of the republic and for its maintenance for ten years.

The Austrian government will purchase, at the end of 1892, the entire business of the telephone companies of that country.

MILITARY.

It is a cause of regret that the arts of war keep pace so regularly with those of peace; and that the greatest incentive offered to inventors in the line of chemical technology is the discovery of some new explosive, and the strongest inducements held out to metallurgists and iron workers are the rewards arising from the production of hard and tough metal for projectiles and for armor. But this is as it is, not as it should be or as we would like it to be; and all that the chronicler can do is to record the progress that has been made in the direction of military destruction and defense.

It will be noted that the important subjects of Ordnance and Firearms are treated under a separate

head; and that only those explosives are here considered which are available for military use, the rest being noted under the caption of Industrial Technology.

DEFENSES OF NEW YORK HARBOR.

The engineering department of the United States Army is perfecting the last details of the plans for a work of vast importance, as it will complete the defenses of New York Harbor against any known power of war. These plans are for a great fort of modern mortar batteries, to be constructed facing the ocean and defending the broad gateway of the harbor.

October 1, the United States fulfilling the oft and earnestly repeated requests of the War Department, acquired fifty acres of Plumb Island, lying at the east end of Coney Island, and ground has been broken for the most noteworthy of modern batteries for vertical fire.

For many years the engineers of the War Department have been casting solicitous glances at the most dangerous omission in the line of defenses about the ocean entrance to New York Harbor, rendered every year more dangerous by the improvements in carrying capacity and destructiveness of the guns placed on ships of war. Besides the two or three narrow channels that are navigable through the entrance to New York Harbor in the waters between Coney Island and Sandy Hook, there is a pocket of deep water approaching the Long Island shore from the ocean, some miles to the east of these channels,

that is navigable to any vessel, whatever may be her draught.

By this deep pocket a man-of-war could arrive at a safe anchorage in Rockaway Inlet. Less than six miles away from this anchorage are the outlying wards of Brooklyn, two miles further is the East River, and another mile beyond is the heart of New York City. From this inlet a hostile ironclad could bombard Brooklyn and New York with a destruction unparalleled in the history of bombardment, and there could be no effective reply to this attack. Fort Hamilton and Fort Wadsworth, guarding the Narrows between the upper and lower bays, would be nine miles away from the disturber, safely anchored in Rockaway Inlet, and these forts have no armament that could throw shell such a distance.

In 1882 General John Newton and a body of engineers from the army made a critical examination of this pocket with a view to perfecting the defenses of the great twin cities. They found that this deep water could be brought under fire in a circle having Plumb Island in the center with a radius of six miles. They recommended the acquisition of Plumb Island by the Government and the immediate construction of fortifications there. Since that time several schemes have been proposed for guarding the entrance of New York Harbor that would include the defense of this deep-water approach to the shore of Long Island. Soon after the Act of Congress, approved August 18, 1890, to purchase lands for defensive purposes, Colonel G. L. Gillespie, constructing engineer of the fortifications at the port of New York, was instructed by the War Department to examine

into the feasibility of building defenses on Plumb Island. He reported favorably on the scheme and proposed the acquisition of fifty acres of the island to be covered by mortar batteries.

Plumb Island is partly in the rear of the low bar of sand forming the eastern end of Coney Island known as Point Breeze. The island has a low, slanting beech, backed by a few sand hills and stretches of salt meadows. Behind, across Hog Creek and Broad Creek, the low meadow land extends back for many hundred acres. The highest spot on the island is not fifteen feet above mean high tide. During the heavy seas of early spring a large part of the island is under water.

The importance of the work which will soon be begun on this desolate little slip of sea sand cannot be overstated. It includes the entire outlying ocean defense of the greatest of America's harbors and the protection from bombardment of its greatest cities.

The new mortar will command not only the deep-water pocket that would allow an ironclad to approach the shore from the ocean, but in the longest range of its guns can defend the channels of the Narrows against the entrance of a foreign hostile fleet to the harbor of New York. In case a fleet of warships succeeded in entering the lower bay it could join in the grand conflict that would arise when they met the guns of the forts that stand at the entrance to the upper bay ; while the Plumb Island batteries will be able to render this assistance to the bay fortifications until the hostile men-of-war have drawn within a mile or two of the big guns at the Narrows. Forts

Wadsworth and Hamilton could not drop a single shell on a man-of-war anchored in Rockaway Inlet, ten miles from their mortar batteries. From the forts on Plumb Island a line drawn almost due southward will cross the whistling buoy which marks the entrance to Gedney's Channel, a distance of less than six nautical miles.

The Plumb Island mortar batteries are to be arranged in two fortifications of earthworks, standing side by side and facing the ocean at a southwest angle. Each fort is to be 600 by 400 feet. The ramparts are to be 35 feet above ebb tide, and the guns will rest on a body of cement raised ten feet above low water.

The interior of each fort is to be divided into four pits, each containing four twelve-inch howitzers. The guns will be fired out of a great well, as the earth walls of the fort will rise twenty-five feet above the level on which the cannons are operated. The mortars will thus be entirely invisible from the ocean. In the deep pits the guns will be perfectly protected from the impact of the shot thrown by the enemy, as the mounds of earth forming the ramparts are to be of a thickness impenetrable by any known projectile. Between the pits will be storage magazines for powder, protected by masonry and earth, and there are to be extensive magazines for high explosives located at some distance from the batteries. The powder magazines for each battery will hold 100 tons. In the rear the two forts will not be parquetted, but will be left open.

The only way that the Plumb Island batteries could be silenced in time of war would be by destroying the earthworks. They could not be attacked by mortars

from the ocean unless a problem in naval engineering was solved that has so far proved impossible of solution These are mechanical difficulties resulting from the recoil of heavy guns, that prevent their firing at an elevation exceeding 15 degrees, while a mortar is most often fired at 30 degrees and upward. The large guns forming the armament of a man-of-war are only for horizontal fire, and the only vessel equipped with cannon for vertical fire is the *Vesuvius*, which have been proved a failure. It is, therefore, safe to say that the gunners who may be called upon to operate the howitzers in the pits at Plumb Island in case of war will not suffer from shot thrown into the sky above them by guns on the ships whose attack they will repel.

The thirty-two great guns for the two Plumb Island batteries are to be of the new pattern of twelve-inch howitzers, of which successful tests have been made at Sandy Hook. They are breech-loading, built-up, steel lined, rifle bored, and steel hooped. They are much longer than the old pattern of mortar, and are capable of extreme accuracy in firing. The projectiles for one of these monster cannons, which, dropped on the deck of the best armored ironclad in existence, would pierce the entire ship, is of steel, three feet long, weighing 625 pounds. Eighty pounds of powder will drive this large projectile eight miles. The gun will also throw shells containing high explosives. By this means the fort could drop enough nitro-glycerine on a ship's deck to scatter an ironclad into ten thousand pieces.

The important work at Plumb Island will go on coincidently with the completion of the fortifications at Sandy Hook.

POSITION AND RANGE FINDERS.

The position finder is a device of Lieutenant Fiske, by which a gunner may know the direction and distance of an object which he cannot see, but which can be seen by two observers at opposite ends of a base line. It consists of a range finder at the gun, in electrical communication with the two observing stations, the record from each of which is made at the gun station.

Welden's range finder, as now made, consists of a metal box on the lid of which are three prisms, one above the other. The upper one is right angled and is mounted with the right angle outward; and looking in its left-hand corner there will be seen, by double reflection, objects lying on the right of the observer. Below this is a second one with a principle angle of 88° 51′ 15″, and below this a third with a principle angle of 74° 53′ 15″. There is also a level and a compass. To use the instrument the observer stands so that the object the range of which is required stands at his right hand, and looking into the left-hand corner of the upper prism views it there by double reflection from the internal face of the prism. At the same time, looking through an opening in the lid below the prism, he selects some object nearly in line with the image seen in the prism. He then shifts his position until the two images coincide, in which case lines joining him with the two objects will make right angles with each other. He then marks his position on the ground, and shifting the instrument, looks through the left-hand corner of the left prism,

when he again sees the image of the object, by double reflection, but to the right of the lining object. He then retires, keeping in line with his first position and with the first lining object, until he reaches the position where the two images again coincide; and the line joining them and the observer will make an angle of 88° 51′ 15″. In this case the distance to the desired object will be fifty times the distance paced. A longer base and greater accuracy may be had with the second prism, which will give the range of the object as 25 times the distance paced. The error in use is from two and a half to three per cent.

A new type of shell fuse by Berdan utilizes the rotary motion of the shell in passing through the air, so as to cause the shell to explode when it has made the number of rotations at which the fuse has been set. With one screw and one small wheel the motion of the shell is reduced 1200 turns to one of the index wheel. The tendency of the shell to turn the entire fuse around bodily with the shell is counteracted by a weight.

It is proposed to employ railway lines following the coast as a means of military defense, using six-inch breech-loading guns, of five tons, fired at a right angle to the line, and of course making use of machine guns. In a total length of 1900 miles of English coast, 1270 could be defended from the railways and 425 are inaccessible.

Snow breastworks six feet thick have been shown to be proof against bullets fired from a distance of

300 paces. If well packed, five feet will do; if an outer crust of ice is formed by natural causes, four feet will suffice; and if an artificial crust is formed by pouring water, 3½ feet will answer for the same degree of protection.

A committee of the French War Office recommends a buckler of aluminium and copper for the use of troops.

EXPLOSIVES.

Apyrite, the new Swedish smokeless powder, is based upon highly nitrated cellulose, giving a low pressure of 2200 to 2500 atmospheres, and an initial velocity of 630 to 650 meters, with no flame, and slight heating of the rifle. It is like ordinary black powder in appearance, and the products of explosion give an alkaline reaction. It is to a high degree unaffected by rubbing and blows, and burns, even when ignited in large quantities, without an explosion—as proved by an accidental ignition of 80 kilometers, the glasses in the room in which this explosion occurred not being broken. It does not alter its constituency by heating even to a high temperature, and does not mass together on being stored. With the present Swedish rifle, 3½ grams of apyrite was used with a bullet weighing 14½ grams, resulting in an initial velocity of 640 meters and a pressure of 2260 atmospheres.

Ammonite is a new explosive consisting of a mixture of 81½ per cent. ammonium nitrate and 18½ of mononitro-naphthaline. Being free from chlorates

it is not liable to spontaneous explosion nor to decomposition. Having no picric acid or chlorinated derivatives of hydrocarbons, it yields no injurious or corrosive fumes. It is put up for use in lead foil cartridges and exploded by a detonator. A 29-pound projectile was thrown from a mortar, elevated 45°, 320 feet by a five-gram charge as against 289 feet by a similar charge of number one dynamite, and 136 by an equal weight of gunpowder. So far it seems to be of use in quarrying only in soft material.

A new explosive, called fortis, is being tried by the Belgian government. It is said to have a force of from 30 to 40 per cent. more than that of any other explosive, surprising even its inventors. A mine 13 feet deep was drilled in the solid rock and charged with a relatively small quantity of fortis. It detached a mass over 200 feet in height, breaking it into 50 to 60-pound pieces, and projecting them 350 yards.

There are many other explosives which have been tried during the past year, with greater or less success, but as many of them have been offered to do service in the arts of peace they are not described under the heading Military. For further mention of them the reader is referred to the heading Industrial Technology, and he is advised to consult the Index for other items bearing directly or indirectly on military subjects.

MILITARY DOVECOTES.

The system of military dovecotes is being developed rapidly in Europe. Both France and Germany have large establishments and improved systems of inter-

communication by pigeon dispatch. Paris is to have ten cotes of 720 birds each; Langres, five cotes, 3600 pigeons. There are in Paris 11,000 pigeons, of which 5000 are trained; and in the suburbs 7000, of which 3000 are trained. At Roubaix, which has only 100,000 people, there are 15,000 pigeons. In all France there are 100,000 trained pigeons. A pigeon will fly from Paris to Lyons in eight to nine hours, a distance that it takes a train thirteen to accomplish.

ORDNANCE AND FIREARMS.

As a matter of convenience this subject is treated apart from general military matters, under which there will be found notes akin to some of those here noted—as for instance Explosives, some of which are mentioned under the heading Military, and others of which may be found chronicled under that of Industrial Technology.

The contest still goes on between the makers of armor and those who produce cannon by which to pierce them. As a general thing the side which produces the latest invention has the advantage if only for a while; each "impenetrable" armor-plate some day succumbing to a new projectile, and in turn each irresistible projectile meeting its match in the latest armor-plate.

At present the principal novelty seems to be the production and test of rapid-firing cannon, which are a development of the mitrailleuse, as the latter was of the ordinary revolving pistol.

Disappearing turrets for quick-firing cannon are now produced. In one style (Maxim-Nordenfelt) the turret is raised and lowered by hydrostatic means, and as it practically floats is readily trained at any angle in a horizontal plane.

Another turret is raised and lowered by a rack and pinion, being counterbalanced. It turns on balls.

In the third type, the gun does not disappear; its muzzle remaining projecting beyond the embrasure. A fixed circular armor belt rests on the top of a wall of concrete forming the pit for the gunners; and the movable protection is an armored cupola, pear-shaped on top and having a roller path on its under side: rollers bearing on rings fixed to the concrete enable the turret and the gun to be turned.

Japan has been having some very heavy Caret guns made by the Compagnie des Forges et Chantiers de la Méditerranée. They weigh 66 tons, are 12½ inches bore, 41 feet 8 inches long, have a maximum weight of projectile of 1034 pounds, require a powder charge of 562.2 pounds, and give a muzzle velocity of 2262 feet per second, and a penetration of wrought iron of 45.16 inches. Their maximum range is over 13 miles, thus showing that Japan leads the world in the actual power of her heavy guns.

The new rapid-fire cannons which have been adopted by Russia throw 40- to 80-pound projectiles 10 to 15 times per minute, nearly seven miles; each one capable of piercing a 20-inch wrought iron plate. The force of the recoil is made to bring the gun back into position at each shot.

The U. S. government has made a contract with the Bethlehem Iron Co. for one hundred new high-power guns, of which 25 are to be 8-inch breech-loading, single charge, built up, forged steel rifle guns, 50 10-inch, and 25 12-inch, of the same pattern. The price is $3,785,850.

In a new automatic magazine rifle the gas from the first cartridge fired presses a piston and spiral spring, which on its recoil opens the breech, removes the empty cartridge, and reloads and cocks the gun. The best results have been eight shots in five seconds.

Tests have been made, by a board of army officers, of magazine small arms, the caliber having been settled upon as 0.30 inch instead of 0.45, as of old. The new cartridge has a bottle-necked shell, and when loaded is 3.09 inches long; this being ten times the greatest diameter of the bullet, which has three grooves for lubricant. The bullet is of hardened lead in a copper jacket: the jacket being to enable it to go through the grooves without being stripped. The bullet weighs 230 grains, the charge 36 grains of smokeless powder. The initial velocity is nearly 2000 feet; the projectile is flat, and the range about 4000 yards.

The Swiss magazine rifle has as its most striking feature the large number of cartridges that its magazine contains. It is 1½ times the diameter of a cartridge, and the cartridges lie in it alternately right and left. It is filled from pockets of six cartridges

each; although it may be filled with single cartridges. A cut-off will put the magazine out of connection and the piece may then be used as a single loader. It takes eight seconds to charge the magazine with the 12 cartridges. The breech motion is worked by a straight line movement as in the Mannlicher rifle; the bolt being pushed in and out and not turned. The breech plug is locked at its rear end. This rifle will fire 20 aimed shots per minute, when used as a single loader; with the magazine 30 in the same time, and 40 without aiming. The cartridge case is of millboard with metal lips, and is of but slight value.

Russia has decided to use the Mauser rifle, which will be made in France. Its caliber will be 7.62 mm.; its magazine will have five cartridges.

It is said that the bore of the Austrian rifle is to be reduced to 5½ mm. (0.216 inch).

EXPLOSIVES.

Progress in field artillery points to the universal use of smokeless powder, the use of high explosives for shells, increase in the length, and therefore the capacity of the shells, the employment of field howitzers or mortars, and increase in the muzzle velocity of guns and in the amount of ammunition carried.

But after making thorough tests of the various kinds of smokeless powder, including American and English, England rejected its use for small arms, owing to its not being compatible with the use of the uniform cartridges adopted by the British army, and

also on account of its extremely rapid combustion; but has decided to use it in cannon, a fourfold gain in the velocity of projectiles being obtained thereby.

A NEW PROJECTILE.

Hiram S. Maxim has invented an armor-piercing projectile having two annular air chambers between its front and rear. The rear part is designed to be moved forward relatively to the body, when acted upon by the explosion of the powder charge in the gun.

METEOROLOGY.

July 1 our Weather Signal Bureau was turned over to the Department of Agriculture, with the intention of making a systematic investigation of the climatic conditions of the various sections of the country, in order that a full knowledge of them and their effects should be available for the farmer.

Among the appropriations made was one for the purpose of enabling the oft proposed scheme of making rain fall at will, in dry seasons and in dry places, by the action of the atmosphere caused by cannonading and explosion of dynamite, hydrogen balloons, etc. These experiments, undertaken in the State of Texas, and elsewhere, did not prove a success. They excited a great deal of interest and discussion; the two principal papers against the feasibility of the plan being by Professor Simon Newcomb in the *North American Review*, and by Professor Edwin J. Houston, before the Electrical Section of the Frank-

lin Institute of Philadelphia. From the latter the following paragraphs are taken:

The following general conclusions may, in view of the present state of meteorological science, be properly drawn:

(1) That rain can never be made to fall at will by mid-air explosions on any part of the earth's surface, irrespective of the climatic conditions there existing.

(2) That during certain meteorological conditions, mid-air explosions may result in rainfall over extended areas.

(3) That the liberation of energy, necessary for such rainfalls, is due not to the mid-air explosions, but to the energy stored up in the moist air from which the rain is derived.

(4) That the meteorological conditions which must exist for the successful action of mid-air explosions would probably, in most, though not in all cases, themselves result in a natural production of rain.

(5) That a comparatively high difference of electric potential between different parts of the air, or between the air and earth, is possibly favorable when taken in connection with other meteorological conditions for artificial rain-making.

(6) That an undirected mid-air explosion is not so likely to produce rain as an explosion in which the main tendency of the energy liberated is to cause a general uprush of the air.

It has been shown that the weather of Kansas divides itself into seven-year wet and dry periods, and that the rainfall there is steadily increasing.

AËRONAUTY.

A FLYING machine invented by Laurence Hargrove, of Sydney, N. S. W., is propelled by compressed air stored in a tube which forms the backbone of the construction. This is two inches in diameter and 48¼ inches long, containing 144.6 cubic inches. Its weight is 19.5 ounces and the working pressure 230 pounds per square inch. The engine has a cylinder 1¼ inches diameter, 1¼ inch stroke; and the total engine weight is 6¼ ounces. The air is admitted and exhausted by a valve worked by tappets. The piston is of vulcanite. The wings are paper and weigh three ounces. In a dead calm the machine flew 368 feet.

H. S. Maxim was at work in June on a flying-machine of silk and steel, with a plane 110 feet by 40 feet, with heavy wooden screws 18 feet in diameter, driven by a condensing petroleum engine. He claims that one horse power will carry 133 pounds 35 miles per hour; and that the screw will lift 40 times as much on the propelled plane as it could push. A motor weighing 1800 pounds, and which can push 1000 pounds, should therefore lift 40,000 pounds. The estimated weight of engines, generator, condenser, water supply of two gallons per hour, petroleum 40 gallons per hour, and two men, is 5000 pounds. Thus with a steam kite weighing 6800 pounds gross he hopes to have an ascendant power of 40,000 pounds, or 11 tons more than the dead weight.

Mr. Charles Carson, of Grenoble, France, has designed an apparatus by which one may fall 1000 feet; the fall to be broken by a well filled with water. The velocity at 1000 feet would be about 80 meters per second; nearly three times the speed of a fast railway train.

In March Prof. Renard was building a dirigible air ship of over 3000 cubic yards capacity; the motor being made of aluminium. It was to leave Meudon and sail between Versailles and Paris.

The idea of reaching the North Pole by balloon does not seem to meet with much approval, even from the French Society of Aërial Navigation, which pronounced unanimously against it. It was projected by MM. Hermite and Besançon.

The Illinois air ship made a very successful trip from Mt. Carmel to Chicago. It was carried on a way freight train.

The *Cosmopolitan Magazine* has offered prizes for the best essays on practicable methods of aërial navigation.

ASTRONOMY.

THERE seems to have been during 1891 but little astronomical matter worthy of special chronicle for the use of the general reader, and as the space available for the record of all the happenings in the world of science is necessarily limited in the present work, the reader will pardon the omission of mention of

occurrences which would interest comparatively few. Of course omission to note things that did not happen need not be laid at the writer's door.

The transit of Mercury was observed on May 9th at the Lick Observatory with the 12-inch equatorial. No bright spot was seen on the planet, nor any atmospheric ring, such as was seen about Venus at the transit of December 6, 1882. Nothing was seen on the sun's disk that could be taken for a satellite.

There seems to be some indication, observed by the Lick telescope at Mount Hamilton, that one of the moons of Jupiter is double.

The spots that have been noticed on Venus seem to be of a pronounced character.

Mr. A. Stanley Williams, of Burgess Hill, Sussex, England, has discovered three delicate but distinct markings on the equatorial ridge of Saturn; the first and third round bright spots, the second a smaller dark marking on the equatorial edge of the shadow belt forming the southern boundary of the white zone.

During the forthcoming decade there are to be four available total eclipses—one in South America in 1893, one in Siberia in August, 1896, one in India in January, 1898, and one in the United States in May, 1900.

It is proposed to erect an observatory upon Mount Blanc, at a height of 15,781 feet above sea level, upon the very summit. It is to be of iron, 85 by 20 feet.

AGRICULTURE.

THE caprification of figs has existed since ancient times, but authorities say that its benefit has been disputed. Caprification is the process of accelerating the ripening of figs by placing on the cultivated plant branches of the wild fig, the insects on which fly to the cultivated figs and puncture them for the purpose of laying their eggs. The fruit thus stimulated ripens earlier. According to another authority, it is supposed that the little insects insure fertilization by carrying the pollen from male flowers near the opening of the fig down to the female flowers.

G. C. Roeding, a fruit grower of Fresno, Cal., is a believer in caprification, and he has shown to the State Board of Trade the results of his experiments. He sent to Smyrna five years ago for wild and cultivated cuttings. Last year all of the figs that grew on the cultivated cuttings, which produced abundant crops, did not mature. They fell before they were ripe. This year he took the pollen of the wild fig and inserted it into some of the cultivated figs, which filled and matured, while the other fruit fell. The seeds of the ripened figs had fertile kernels. It is believed that the fruit grown on the many importations of Smyrna cuttings in California may be made marketable by introducing the wild fig.

AMERICAN CAMPHOR.

Interest in the growing of camphor trees in the United States is stimulated by the increase in the cost of the gum by reason of its use for smokeless

powder and in the manufacture of celluloid goods. The cultivation of the camphor plant is being tried at Palatka, Fla., and our Department of Agriculture will have a large supply of trees for distribution in the spring of 1892. Camphor trees have done well in California. A tree in Yuba County reached a height of 50 feet in 14 years. As a matter of ornament the trees are desirable because they are exempt from insect parasites.

NEW METHODS OF VINE PRUNING.

Thoreau's system of pruning grape-vines consists in bending down a branch and covering its lower end in the earth, leaving exposed a shoot which projects above the surface of the earth at the covered part; then each vine is made to do double duty.

Cazanave's system is to bend each plant to one side about a foot above the ground, and encourage the upward growth of shoots which each year are turned down into the earth, there to take new root.

In the Thoreau system the stalk carries two branches, one of which is the fruit branch with 12 to 15 buds, and the other the wood branch with two to three eyes to furnish the shoot for the next year's fruit branch.

A contributor to *Grazhdanin* shows that the frequent lack of rain and the abnormal heat of the last few years, in the agricultural region between the Volga and the Dnieper, were due to the drying up of the turf swamps in the government of Pinsk. The government has expended many millions in the work of turning these swamps into rich meadows. Now it

appears that ten times as much as was gained by that work is lost every year by the effect it produces on the whole region. *Novoye Vremya* remarks that these bad consequences were foretold by scientific observers. Other possible evil effects were also foretold. It was shown by expert strategists that in case of war with Germany the dry roads which were created by that work might cause serious trouble to the army which has to guard the western frontiers, while the swamps formed a natural barrier to foreign armies in that place.

The Australian irrigation colonies on the River Murray have been proved to be a success. There are now 90 miles of main tunnels and 140 of subsidiary. The annual death rate is only 4.4 per thousand.

COTTON PICKING BY MACHINERY.

A mechanical cotton picker, devised by a Mr. Campbell, has 330 fingers, or spindles, projecting from and through a hollow cylinder, each ten inches long and having at the end a brush or tip of fine wire ; and set in grooves, radially, is horse hair, clipped so that it projects from the fingers about $\frac{1}{12}$ of an inch. These hairs catch in the fiber and drag it from the boll. The machine is four feet wide, seven feet long, and $5\frac{1}{2}$ feet high, weighing 1200 pounds, and is drawn by two mules. It gathers about 300 pounds an hour, at a cost said to be only $1.50 per bale, as against $16 now paid for hand work.

GOVERNMENT TIMBER TESTS.

The Department of Agriculture at Washington has commenced a series of tests of timber, with a view to determining the essential working properties of our various woods, and the circumstances which influence them; the influence of seasoning in different degrees upon quality; the effects of age, speed of growth, time of felling, and after treatment upon quality; the relation of structure to quality; the extent to which weight is a criterion of strength; the influence of climatic and soil conditions upon quality; the effect of tapping for turpentine upon the quality of pine timber, etc. The studies are to be made in the botanical laboratory at the University of Michigan and Ann Arbor, and at the St. Louis Test Laboratory.

It has been said that a cure for phylloxera consists in the application to the vine plant of ¼ ounce of quicksilver in very minute particles, mixed with an equal weight of pulverized clay, for each plant; but up to date no definite information as to its efficacy seems to be at hand.

Banana flour has been received in this country from Durban, South Africa.

Olive oil is to be made in considerable amount in Sonoma, Cal., where there are now 60 acres of olive trees and 700 more are being planted. The establishment will cost $250,000.

It has been found that silk worms may in hunger

be made to eat the leaves of dandelion and salsify, particularly if mixed with mulberry leaves ; and this paves the way for sericulture in Germany and other countries.

A new remedy for the phylloxera is bisulphide of carbon, mixed with vaseline, which reduces its volatility and increases its diffusibility.

Our government is introducing reindeer into Alaska, where they will be treated like domestic animals.

INTERCOMMUNICATION.

New and proposed routes of intercommunication are always of interest to everyone, whether engaged in manufacturing, in selling goods, or in transportation general or particular. The brotherhood of men is rendered more possible and more binding by the completion or even by the mere formal consideration of new routes, better and shorter, from one section of the country to another, or between continents or grand divisions. Under the heads of Railway, Canals, Tunnels, etc., there will be found mention more or less detailed of several such routes ; those which should not be so classified being mentioned below.

NEW ROUTE TO INDIA.

A new mail route to India is proposed by the Dover-Ostend boats through Belgium, Germany, Austria, Hungary, Servia, and Turkey to Salonica, instead of from Calais through France and Italy to

Brindisi. Thirty-six hours out of the 16½ days can be saved by this route, if the trains can be protected from brigands in Turkey, and by some improvements at Salonica.

FROM CHICAGO TO LIVERPOOL.

A company is organized with a capital of a million pounds sterling with which to establish a fleet of ten 1500-ton steamers to ply between Chicago and Great Britain via the Great Lakes. By the Lakes, Welland Canal, and St. Lawrence River, the distance is 4488 miles between Chicago and Liverpool ; via New York by rail 4353 miles ; the time being 337 hours in the latter case as against 346 in the former. By rail to Montreal, and thence by steamer, is 4062 miles, requiring 328 hours.

THE NOVA SCOTIA ROUTE TO EUROPE.

The Terminal City Company has been organized with a view to shorten the passage between America and Europe by making the nearest available land on either side the respective starting-points. The site chosen for the western terminus is on Nova Scotia territory in the Straits of Canso, where there is said to be a fine harbor with good approaches from the interior and by water. The distance saved by this route will be 600 miles, and it is said that the first steamer will soon make her trial trip.

UNIFORM STEAMSHIP ROUTE.

The steamship companies trading between New York and Liverpool have adopted a uniform route for all steamers each way ; being the safest course

they can suggest. The length of the passage will vary from 2900 miles between January and July, to 2775 between July and January, when the North Atlantic is comparatively free from icebergs.

THE CHIGNECTO SHIP RAILWAY.

The Chignecto Ship Railway, in Canada, crosses the narrow peninsula between Nova Scotia and the mainland. It was commenced in 1888, and should have been completed in 1891. There is a basin, 500 feet by 300, at the Bay of Fundy end of the line, with a gate to inclose the water when the tide is out. From this is a lifting dock, 230 by 60 feet, containing 20 hydraulic presses for lifting vessels with their cargoes 40 feet. The extreme weight to be raised is 3500 tons, including the gridiron cradle and a loaded vessel, 2000 tons displacement or 1000 tons register. The railway is double track, 17 miles long, perfectly straight, and on almost a dead level; the steël rails weigh 110 pounds to the yard. A locomotive on each track is supposed to move the largest vessel at the rate of ten miles per hour. This railway has had work suspended on it by reason of the state of the money market; but the rails have been laid for 12 miles, and the line half ballasted.

THE HURON-ONTARIO SHIP RAILWAY.

A ship railway, 66 miles long, is advocated between Lakes Huron and Ontario, whence there should be sufficient enlargement of river and canal to insure a navigable depth of twenty feet from Chicago to the ocean, thus reducing freight rates nearly one-

half. The cost of this scheme would be about $43,000,000.

An electric launch service is proposed on the River Spree at Berlin.

MISCELLANEOUS.

LIGHTHOUSES AND SIGNALS.

IT has been admitted for a long time, in these days of many ships and much travel, that all lighthouse lights should have such distinguishing characteristics as to make it impossible for any mariner suddenly coming to a light to be uncertain whether it belongs to the lighthouse establishment or not, or to mistake one light of the establishment for another. With the swift steamers and great competition of the present time, when vessels are driven almost as fast in fog as in clear weather, a ship running for four or five days, without being able to catch a glimpse of sun or stars, may easily find herself several miles out of the way. If, under these circumstances, a light should be made out unexpectedly, the mariner should be able to tell at once whether or not it belong to the lighthouse establishment, and, if it be so, he should have the means of knowing immediately what light it is. Many naval officers say that the system of time intervals between flashes is unsatisfactory on account of the difficulty of accurately timing these intervals when a ship is rolling or pitching heavily. Atmospheric influences, the nature of which is unknown, cause apparent variations in the intervals by making them seem

sometimes greater and again smaller. Barometric changes offer greater or less resistance to the wings of the governor of the driving mechanism, and these cause variations. In a word, the present system, founded on time intervals, is not wholly satisfactory. In its place is proposed a system of numeral characteristics, or the assignment of a number to each light, this number being given by groups of flashes. Being a system founded on a well-defined principle, no change need be made after it is once adopted.

A committee of Canadian experts, after considering the merits of foghorns as against whistles, and guns as against bombs, has reported that under the most favorable conditions all fog signals are untrustworthy. Sometimes a weak signal has been heard further than a strong one. Shallow water, by unequal heating of the atmosphere, lessens the value of signals. The whistle is superior to the horn, and either is better than the gun or the bomb. For convenience of storage and readiness of handling, bombs are preferred to guns, and they are to be used in all the minor lighthouses of Canada. The committee warns shipmasters against depending on fog signals, they being guides to locality only, and not to distance.

Wigham claims to have produced a new lighthouse burner, giving a light of 8,000,000 candles, which is greater than that of any other in use. It consists of concentric jets, of which 28 are lighted in ordinary clear weather, but there may be used 48 to 108 in thick weather. The air supplied to the burners is heated to a very high temperature before reaching

the jets, and the light is increased by use of solid naphthaline placed in a chamber below the burner.

THE SCLEROMETER.

The sclerometer devised by Turner is an instrument for testing the hardness of various kinds of electroplating. There is a graduated beam with unequal arms like a steelyard, resting upon knife edges which bear upon suitable steel or agate surfaces carried at the head of a pillar. A counterweight, on the short end of the beam, serves to balance the longer arm, and fine adjustment of the beam is by a nut and screw. At the end of the longer arm of the beam is a brass style shod with a small point. A scale pan slides along the long arm, and by its position and the weights it contains determines the pressure put upon any object by the style. The greater the weight required to cause the style to penetrate and mark the surface, the harder the surface.

THE GREATEST PRESSURE GAUGE.

A mercurial pressure gauge has been erected by Caillot, at the Eiffel Tower. It is 984 feet high, and gives pressures up to 400 atmospheres. The tube is of soft steel, of about $\frac{1}{8}$ inch internal diameter, connected at the bottom of the tower with a mercury reservoir. By pumping water into the reservoir the mercury can be gradually raised to the top of the tower. As the tube is opaque, it is necessary to have try cocks; and these are placed about every 10 feet, communicating with vertical glass tubes having graduated scales. A telephone connects the upper and the lower ends of the tube.

MUSICAL.

At a meeting of the Piano Manufacturers' Association of New York City and vicinity William Steinway, chairman of the committee appointed by the association to consider the question of a uniform musical pitch, presented a report, in part as follows:

Your committee recommend the adoption as a standard musical pitch of that A which gives 435 double vibrations in a second of time.

Your committee also recommend the tuning forks made by Rudolph Koenig of Paris, and vibrating for A 435 double vibrations in a second at 68° F., for standard forks; and small forks made by Valentine & Carr, Sheffield, giving the same rate of vibration, for commercial forks.

Your committee also recommend that the trade take such measures as are necessary to place these commercial forks in the hands of tuners throughout the country.

The Académie des Sciences has submitted a new system of musical notation, in which 27 characters replace the 203 symbols now employed to represent the 7 notes of the gamut in the 7 keys.

In Tanaka's new keyed musical instrument for just intonation, the black keys are divided some into two and some into three parts, and one additional shorter and inner key is introduced between the E and F white keys. This arrangement gives 20 notes, which suffice for modulating into a reasonable number of keys with sharp signatures and to provide for modulations into keys with flat signatures when these and the

sharp modulations are not wanted at the same time; six of the notes can be instantaneously changed at any time. No matter what the key of the original composition, it is played in the key of C. For players who cannot transpose at first sight from one key into any other, the piece will have to be recopied. By it any competent organist may, after a few minutes' experience, and a quarter of an hour's practice, play any piece of music correctly in the true musical intonation, a result which has never been attained by any former instrument. The inventor is now engaged in making one with eight stops, and a simplified euharmonic pedal clavier for the Prussian Government.

EXHIBITIONS.

It would hardly be possible that a year should occur without there being one or more exhibitions, national, international, or special, somewhere upon the face of the globe. Just now all interest centers upon the forthcoming Columbian Exhibition of 1893, which is to take place in Chicago, and concerning which the daily papers keep the average reader sufficiently well-informed to at least relieve them of any charge of indifference or neglect.

An exhibition at the London Crystal Palace, opened January 1, 1892, showing first, heavy electrical engineering for electric lighting; second, the utilization of electric currents other than for lighting; third, the generation and utilization of electric currents from primary batteries.

There will be a naval exhibition in Liverpool, com-

mencing February 1, 1892 ; and at this there will be shown many of the exhibits from the London Naval Exhibition.

It is proposed to hold an International Exhibition at Douglas, Isle of Man, in 1892.

A new method of showing machinery in catalogue or photographic illustrations is by the aid of a mirror placed back of the machine, the photograph being taken from a point high enough up to include both the front and the back views of the machine.

The sand blast is being used for cleaning the marble outside of the United States Assay office in Wall Street, New York. The apparatus consists of a "gun" in the form of a sheet tin tube three feet long and two and a half inches in diameter, bent into a goose neck at one end and ending in a two-inch nozzle. The sand is fed through this tube from a hopper, and projected against the work by an air blast. With an air of pressure of two pounds per square inch at the nozzle, one square foot of marble is cleaned, being abraded to a depth of $\frac{1}{64}$ to $\frac{1}{32}$ inch per minute.

The large porcelain factories at Limoges have been experimenting on the reduction of the cost of firing. It is but $2.00 per ton in Bohemia, $2.60 in England, $6.90 in Limoges. The results of tests with oil were that no gases or smoke in any way discolored the china ; and in the muffles there was decided advantage. The effect should be about 15 to 20 per cent. saving in the cost of manufacture.

Compressed air is used at Portland, Or., to blow the dust out of the cushions and other lodging places of passenger cars, being supplied through an ordinary garden hose.

Frugal Bavarians, by a strong electric light, attract insects and moths, and by a suction fan draw them into a small mill, which grinds them up with flour into poultry food.

Dr. J. W. Clowes has devised a method of fastening in artificial teeth between those which have at least the sides remaining. Cavities in the remaining teeth are worked out, and the amalgam is molded into these cavities, and also over the gum between the teeth, so as to press firmly thereon between the teeth, this amalgam being worked to resemble the teeth the places of which are supplied. This has also the effect of locking together the old natural teeth.

Frederick R. Honey, Ph. B., shows that with the aid of a hyperbola any angle may be trisected. The chord of the arc being drawn and trisected and the chord produced $\frac{1}{3}$ its length with $\frac{2}{3}$ of the arc as a transverse axis, and with the $\frac{1}{3}$ point and the $\frac{4}{3}$ point as foci, construct a branch of a hyperbola, which will trisect all arcs having the common chord.

The Prince of Monaco has had built for the study of oceanography a yacht of 650 tons displacement, and having engines, dynamos, and an ammonia freezing apparatus and a water still. There is a search light

of 10,000 candle power. It would permit of sounding being made up to 8000 meters in depth. The Prince's object is to investigate the direction and the velocity of the great surface currents on the ocean. He has thrown over 1700 floats into the ocean between Europe and America.

The estimate of the population of the United States for 1900 is given by our Department of Labor as 76,639,854.

The improvement of the Potomac flats at Washington has gone on until from the Capitol to the Virginia Channel is now one large park, in which there are the Botanical Garden, Medical Museum, Smithsonian Institution, Agricultural Department, Bureau of Engraving and Printing, and the Washington monument. The cost so far has been $1,624,798 ; and the value of the lands recovered is $3,000,000.

Alabama is building macadam roads, with the result that wherever they lead the cotton patch is disappearing and diversified farming taking its place.

The great Leland Stanford, Jr., University was opened formally October 1. Four hundred and forty students were admitted, of whom 95 were girls. Eleven hundred applications for admission have been received.

The American Screw Company has established a branch in Leeds, England.

The harvesting machine companies of the United

States have formed a trust under the name of the American Harvester Company, having $35,000,000 capital. They employ 15,000 men.

Ocean post offices have been approved by our government and are in operation between this country and Germany ; the letters being sorted at sea in the same way as has been done for a long while in the railway post office service.

A Danish engineer, Hanssen, proposes a metric system by which the inch and foot shall be increased to 1.000403 times their present length, leaving the ounce, pound, and imperial gallon the same. By this system the cubic foot would contain just 1000 ounces avoirdupois ; 16 cubic feet would be 100 imperial gallons, and weigh 100 pounds.

A redwood plank, 16 feet 5 inches wide, 12 feet 5 inches long, and 5 inches thick, about ninety per cent. being clear, has been shown ; being taken from a tree 35 feet in diameter and 300 feet high, the rings of which show it to have been 1500 years old. It comes from Humboldt County, Cal.

During the past year an elm tree, 75 feet high and 7 feet in circumference, was moved 12 miles, at Willamette, Ill. A hole was chiseled through about 10 feet from the ground, and through this there was passed a steel bar, bearing upon heavy timber braces.

The beginning of the second century of the American patent system was celebrated by a convention of these interested.

The largest elevators in the world will be these at Weehawken, N. J. They will lift 130 persons 145 feet at each trip. They will be worked on the combined gravity and pressure system; that is, by water from a closed overhead tank in which there is a pressure of air. The cages will be 21 feet 6 inches long by 12 feet 6 inches wide, and 10 feet high. The working pressure is 180 pounds, and with this pressure and a load of 20,000 pounds the lift is at the rate of 200 feet per minute. To enable quiet stopping a perforated apron is attached to the piston, to gradually close the port as it reaches stroke end. As the main control valve is too large to be worked by hand, it is worked by a subsidiary valve and cylinder. The hand rope turns a wheel fixed to a shaft, on the end of which is a crank coupled by a rod to a beam connected at one end to the main valve spindle, and at the other end to the subsidiary valve spindle. Turning the wheel operates the subsidiary valve, which admits and exhausts pressure water from the underside of a subsidiary piston connected to the main valve. A triple safety gear is employed.

There has been constructed in France a chronometer giving the $\frac{1}{1000}$ of a second. Its operation is based upon the use of a chronometer balance beating fifths of a second, a special mechanism causing the balance to describe at each beat a complete circle. The circle being divided into 200 parts, each of these represents $\frac{1}{1000}$ of a second. By reason of the variation in the velocity of the balance at different portions of its stroke, the dial has divisions which are closer at the beginning than at the middle of the

travel. The large dial is divided into 300 parts, representing fifths of a second; and the smaller one shows hours and minutes. An electro-magnet, acting almost directly upon the balance, serves to set in motion or stop the mechanism instantly. A bolt brings the thousandths hand to zero, and sets the spiral so that the balance will move it instantly the current is broken.

"The polar level" is a new integrating machine, analogous to the polar planimeter, for measuring areas. It takes advantage of the fact that the radius vector tracing any curve varies its length in proportion to the length of arc multiplied by the cosine of the inclination of the tangent at every instant; or $dr = \cos. \varphi ds$. The instrument consists of a pair of bicycle wheels connected by framework to run on the curve of the ground, supporting a paper sheet moving as it goes under an arm carrying a pencil, which represents the radius vector. The pole is kept steady by a pendulum; but the arm itself is adjusted by a cam to the angle, as a line connecting the wheel centers gives the tangent of the curve of the ground at each instant. The integrating mechanism is a sliding wheel upon a revolving cone. By the use of the gear train the machine will level and plot a piece of ground on an exaggerated scale. This should reduce the work of leveling ground to simply that of wheeling around a machine about the size of a safety bicycle.

A novel form of flexible tubing has been brought out by T. R. Almond, and described before the So-

ciety of Mechanical Engineers. It consists of coils of round wire, with triangular-shaped wire interposed between the coils. The triangular wire serves two purposes ; one to spread the coils apart, so that the pressure will be exerted on the contact surfaces ; the other to fill the irregularly shaped spaces between the coils of round wire, adjusting itself to the changed form of the spaces due to any given flexion.

Szczeniowski and Piatkowski have brought out a continuous centrifugal separator, driven from beneath and turning 500 times per minute, with a very fine regulator for the discharge of the boiled mass. The first drops are discharged through one opening, the boiled mass freed from the drops through another ; the drained crystals, having remounted the entire filtering surface in the form of a truncated cone, meet with a cylindrical surface which affords a resistance to their escape, and finally they are turned into a circular hopper.

An instrument specially devised for reading journals that are printed in small type, consists of a concave mirror to give an enlarged image of the characters, and which reflects the matter upon a small plane mirror lying upon the sheet of paper just above the line that it is desired to be read. As soon as the reading of the line is finished the apparatus is slid over it.

A machine for making shoe strings out of paper has been invented in Philadelphia.

A new lamp shade is made of aluminium and

glass, and weighs less than five ounces. The shade is a combination of a parabolic with a plain radiating reflector, to which is attached a diffusion plate of ground glass, and the arrangement of these different parts is such as to direct the main portion of the rays into a given zone of illumination, while a minor part is radiated and diffused throughout the room.

A new slide rule has been brought out, especially adapted to solve problems in electric wiring.

A spring washer, got up by the Positive Nut Lock Washer Co., Limited, of London, has a rib of $\wedge$ section where it butts against the nut, and which, when the nut is screwed home, goes into and around the bolt threads. This is said to have originated in America.

Transparent set squares, curves, triangles, and protractors, are now made of celluloid, and seem to be much liked by those who use them.

A silent cab call which has been adopted in London shows a red light for a four-wheeler, and a green one for a hansom.

An attachment to the ordinary mill sprinkling system has been produced, to give an alarm when one or more sprinklers open or leak. There is an ordinary check valve, the disk of which, when raised by the slightest movement of water, pushes a delicate rod into a cylinder filled with oil against a cam to which is connected by a spindle an arm, the friction

roller of which, in moving upward, brings the upper end of a quadrant lever in contact with a spring, closing a circuit.

The Bonwick siphon stopper does not require that the entire contents of a bottle shall be drawn off the first time it is opened. It consists of a glass plug and an India rubber ring. The latter seats itself in a deep groove around the plug, while its outer circumference rests in a groove in the bottle-neck. One end of the glass plug is chamfered so as not to obstruct the flow of liquid too much, while it is there; there is a cross gate going through the groove. Normally the rubber ring makes an air-tight joint both with the plug and with the bottle. When there is pressure in the bottle this is tightened. To break the joint the plug is pressed inward, opening a passage at each side of the cross gate under the rubber ring. On relaxing the pressure on the plug the joint is again made, and the flow stopped.

R. H. Harry, of London, England, has devised a band knife for cutting fabrics, in which the knife or saw is carried upon the peripheries of five large wheels, giving it equal and easy tension throughout its length.

A new blow pipe, intended for jewelers and others of that class, has the advantage of being connected with the gas supply by a flexible India rubber tube, and of having the glass mouthpiece also connected by a smaller flexible tube, thus enabling the apparatus to be readily moved from point to point of the work.

A new saddle has a series of steel springs connecting the upper saddle tree, or seat, with the lower, to relieve the rider from constant jolting. The springs are cone shape, working within each other.

THE END.

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HINTS

TO

POWER USERS.

"The book ought to prove especially serviceable to engineers; although its terse nuggets of practical wisdom will as surely help their employers as well."—*Practical Electricity.*

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